INSTALLATION RESTORATION PROGRAM (IRP) SITE INVESTIGATION REPORT FOR IRP SITE NO.4

VOLUME I

128th AIR REFUELING WING
WISCONSIN AIR NATIONAL GUARD
GENERAL BILLY MITCHELL FIELD
AIR NATIONAL GUARD BASE
MILWAUKEE, WISCONSIN

MARCH 1996

HQ ANG/CEVR
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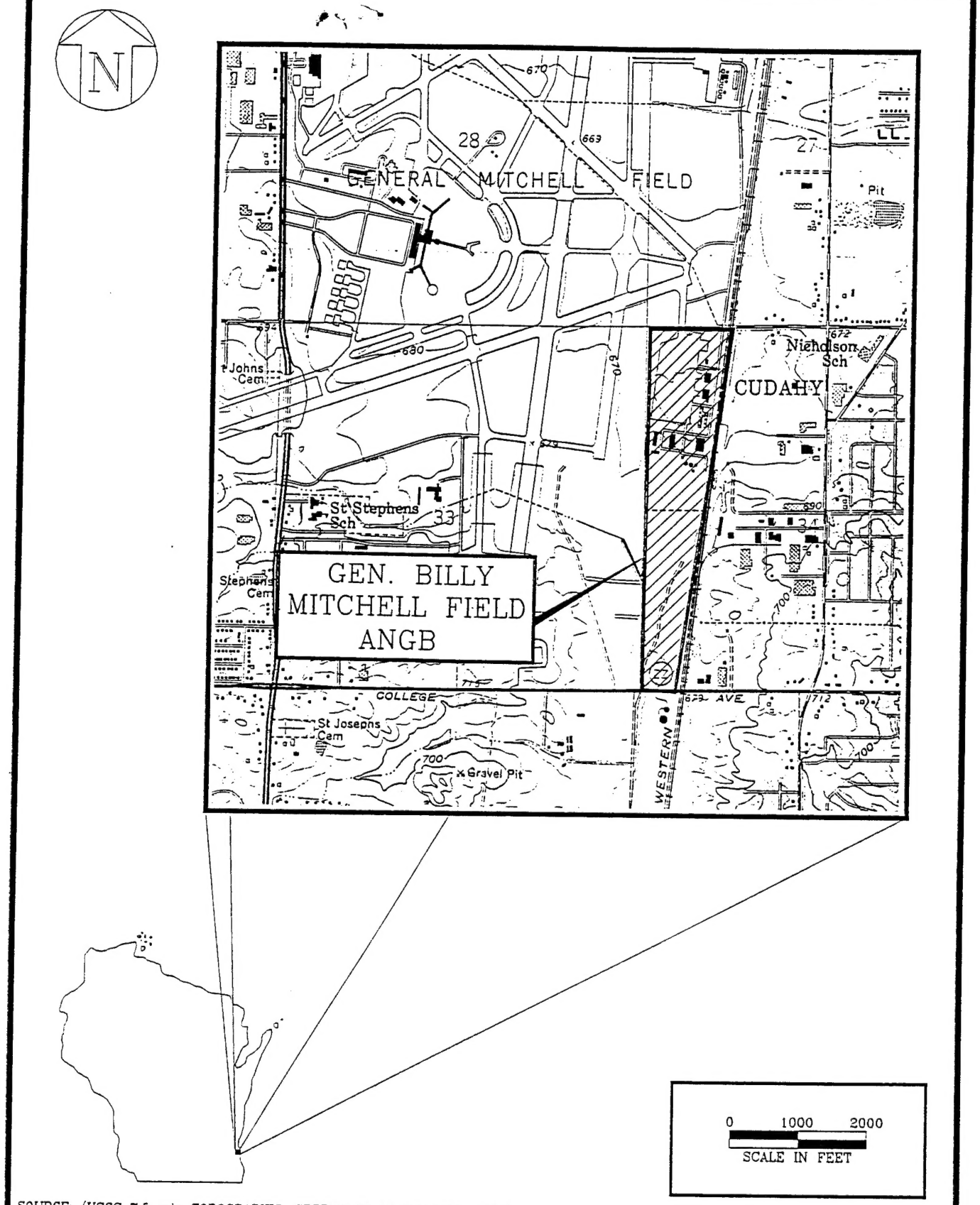

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128th ARW, Gen. Billy Mitchell Field ANGB
Milwaukee, Wisconsin

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Site Investigation Report for IRP Site No. 4, Wisconsin Air National Guard, 128th Air Refueling Wing, General Billy Mitchell Field, Milwaukee, Wisconsin, Volume I. This is the first volume of a three volume site investigation report. One site (Site 4 - Base Drainage Ditch) was investigated under the Installation Restoration Program. Soil and groundwater samples were collected and analyzed. A Remedial Investigation was recommended to (1) further delineate the impacted soil and groundwater in the southern/southwestern area of the base and the area of Bailey's Pond, (2) determine background conditions for the soil and groundwater in the area, and (3) evaluate potential sources of contamination in the soils near Buildings 107 and 108.

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INSTALLATION RESTORATION PROGRAM (IRP) SITE INVESTIGATION REPORT FOR IRP SITE NO.4

VOLUME I

128th AIR REFUELING WING
WISCONSIN AIR NATIONAL GUARD
GENERAL BILLY MITCHELL FIELD
AIR NATIONAL GUARD BASE
MILWAUKEE, WISCONSIN

MARCH 1996

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LIST OF ACRONYMS

ANG	Air National Guard
ANGB	Air National Guard Base
ARARs	Applicable or Relevant and Appropriate Requirements
ARG	Air Refueling Group
ATHA	Ambient temperature headspace analysis
BLS	Below Land Surface
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CGI	Combustible Gas Indicator
cm/sec	Centimeters per seconds
COE	Corps of Engineers
Cv	Clayey land
DD	Decision Document
DERP	Defense Environmental Restoration Program
DoD	U. S. Department of Defense
DOT	U. S. Department of Transportation
DRO	Diesel Range Organics
EO	Executive Order
°F	Degrees Fahrenheit
FD	Field Duplicate
FS	Feasibility Study
GC	Gas Chromatograph
Gen.	General (as in Gen. Billy Mitchell Field)
gal/day/ft^2	Gallons per day per foot squared
GRO	Gasoline Range Organics
GW	Groundwater
HQ ANG/CEVR	Headquarters, Air National Guard, Installation Restoration Program Branch
HMTC	Hazardous Materials Technical Center
HRS	Hazard Ranking System
HSA	Hollow-stem auger
I	Average Hydraulic Gradient
ID	Inside Diameter
IRP	Installation Restoration Program
JP-4	Jet Propulstion Fuel-4
K	Horizontal Hydraulic Conductivity
LTM	Long Term Monitoring
mg/kg	Milligrams per kilogram
mg/L	Milligrams per liter
mL	Milliliters
mmhos	Millimhos
MSL	Mean Sea Level
MS/MSD	Matrix Spike/Matrix Spike Duplicate

LIST OF ACRONYMS (Concluded)

MW	Monitoring Well
n	Net Effective Porosity
NFA	No Further Action
NR720	Chapter of the Wisconsin Administrative Code
OpTech	Operational Technologies Corporation
PAHs	Polynuclear Aromatic Hydrocarbons
PA/SI	Preliminary Assessment/Site Inspection
PID	Photoionization Detector
POL	Petroleum, oils, and lubricants
ppb	Parts per billion
PPE	Personal protective equipment
ppm	Parts per million
PVC	Polyvinyl chloride
PZ	Piezometer
QA/QC	Quality Assurance/Quality Control
RA	Remedial Action
RD	Remedial Design
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
SARA	Superfund Amendments and Reauthorization Act
SI	Site Investigation
TAW	Tactical Airlift Wing
TCF	Tactical Control Flight
TPH	Total petroleum hydrocarbons
μg/kg	Micrograms per kilogram
μg/L	Micrograms per liter
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UST	Underground storage tank
v	Velocity
VOA	Volatile Organic Analysis
VOCs	Volatile Organic Compounds
WDNR	Wisconsin Department of Natural Resources
WESTON	Roy F. Weston, Inc.
WMI	Waste Management, Inc.
WSPL	West Shore Pipeline, Inc.

SECTION 1.0 INTRODUCTION

This Site Investigation (SI) Report presents the results of investigation activities conducted at the 128th Air Refueling Wing (ARW), General Billy Mitchell Field Air National Guard Base (ANGB), Milwaukee, Wisconsin (Inside Front Cover Figure). The Phase I Records Search conducted by R. F. Weston, Inc. (WESTON), in 1984 and the Addendum to the Installation Restoration Program (IRP) Phase I Records Search conducted by the Hazardous Materials Technical Center (HMTC) in 1986 identified the drainage ditch, IRP Site No. 4, as a potentially contaminated site.

Headquarters Air National Guard, Installation Restoration Program Branch (HQ ANG/CEVR) authorized Operational Technologies Corporation (OpTech) to prepare an SI Work Plan and conduct the SI of IRP Site No. 4 at the General Billy Mitchell Field ANGB. The SI was conducted as outlined in the SI Work Plan approved by HQ ANG/CEVR in September 1994. The SI was conducted under the authority of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), enacted in 1980, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986.

1.1 INSTALLATION RESTORATION PROGRAM

The Defense Environmental Restoration Program (DERP) was established in 1984 to promote and coordinate efforts for the evaluation and cleanup of contamination at Department of Defense (DoD) installations. On 23 January 1987, Presidential Executive Order (EO) 12580 assigned specific responsibility to the Secretary of Defense for carrying out DERP within the overall framework of SARA of 1986 and the CERCLA. The IRP was established under DERP to identify, investigate, and clean up contamination at DoD installations. The IRP focuses on cleanup of contamination associated with past DoD activities to ensure that threats to public health were minimized and natural resources were restored for future use. Within the Air National Guard, HQ ANG/CEVR manages the IRP. The IRP is divided into six phases as illustrated in Figure 1.1, and defined and described in the following subsections.

1.1.1 Preliminary Assessment (PA)

The PA process consists of personnel interviews, a records search, and site visits designed to identify and evaluate past disposal and/or spill sites that might pose a potential and/or actual hazard to public health, public welfare, or the environment. Previously undocumented information is obtained through the interview process. The records search focuses on obtaining

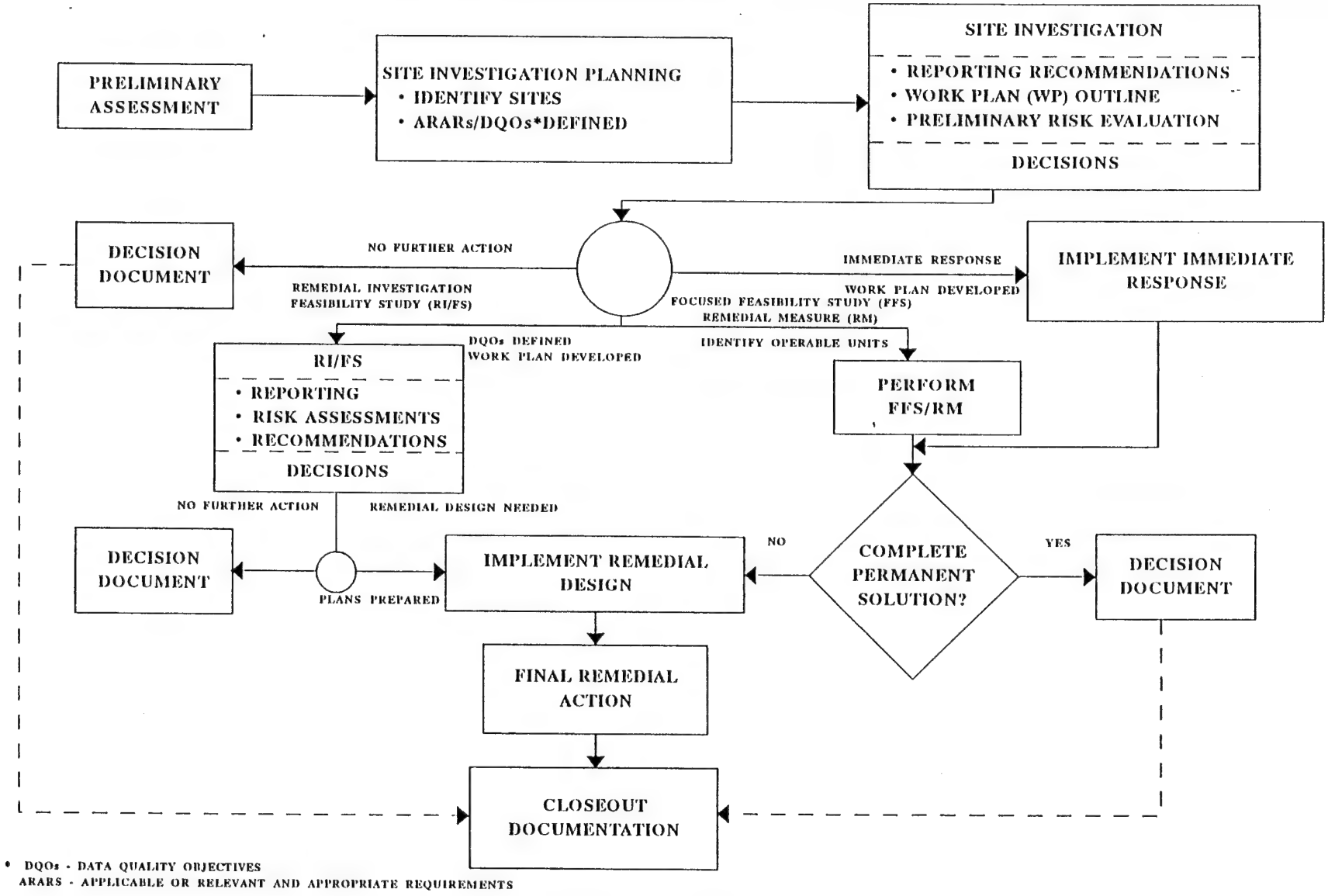

FIGURE 1.1

FORMS\LANDSCAP

FLOW OF INSTALLATION RESTORATION PROGRAM TASKS

128th ARW, Gen. Billy Mitchell Field ANGB
Milwaukee, Wisconsin

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MARCH 1996

useful information from aerial photographs; installation plans; facility inventory documents; lists of hazardous materials used; subcontractor reports; correspondence; Material Safety Data Sheets; Federal/State agency scientific reports and statistics; Federal administrative documents; Federal/State records on endangered species, threatened species, and critical habitats; documents from local government offices; and numerous standard reference sources.

During the early IRP program (1970s to mid-1980s), Phase I consisted of problem identification/records search. Currently, the former Phase I is known as the PA. A Phase I Records Search was initially conducted at General Billy Mitchell Field ANGB by Roy F. Weston, Inc. (WESTON), in November 1984. In order to update the WESTON report and verify the data contained in the original Records Search, an Addendum to the Phase I Records Search was conducted by Hazardous Materials Technical Center (HMTC) in November 1986.

1.1.2 Site Investigation (SI)

The SI phase consists of field activities designed to confirm the presence or absence of contamination at the potential sites identified in the PA or during non-related IRP investigations, and to provide data needed to reach a decision point for the site. The activities undertaken during the SI generally fall into three distinct categories: screening, confirmation, and optional activities. The investigation may also address preliminary risk evaluations to identify potential receptors and to evaluate potential risks to human health and the environment.

Screening Activities

Screening activities are conducted prior to drilling activities to gather preliminary data on each site. Screening activities may include the use of such tools as a magnetometer survey to locate underground lines, tanks, and utilities; soil gas surveys for developing the optimum number and location of soil borings needed to delineate soil contamination, and to be used as a guide in the selection of monitoring well locations; or the installation of a piezometer network in order to determine groundwater flow direction prior to installation of any groundwater monitoring wells.

Confirmation Activities

Confirmation activities include the installation of soil borings and/or monitoring wells; specific media sampling; and laboratory analysis to confirm either the presence or the absence of contamination, levels of contamination, and the potential for contaminant migration. Information

obtained during the subsurface investigation is also utilized to define the installation and site hydrology, geology, and soil characteristics.

Optional Activities

Optional activities are used if additional data are needed to reach a decision point for a site, such as no further IRP action is warranted, prompt removal of contaminants is necessitated, or further IRP work is required. Optional activities may include increasing the number of soil gas sampling points or the number of soil borings and/or monitoring wells to be drilled.

The general approach for the design of the SI activities is to sequence the field activities so that data are acquired and used as the field investigation progresses. This is done in order to determine the absence or presence of contamination in a relatively short period of time, optimize data collection and data quality, and to keep costs to a minimum. Information, data, and analytical results obtained from the SI field investigation will support the selection of one of the following decisions:

No Further Action (NFA) – Investigation did not indicate harmful levels of contamination that pose a significant threat to human health or the environment. Therefore, no further IRP action is warranted and a Decision Document (DD) will be prepared to close out the site.

Immediate Response – Investigation indicates that the site poses an immediate threat to public health or the environment. Therefore, prompt action to eliminate the threat is warranted.

Remedial Investigation/Feasibility Study (RI/FS) – Investigation indicates further IRP work is required and the next phase of the IRP needs to be implemented. The RI is described more fully in the following subsection.

1.1.3 Remedial Investigation (RI)

The objectives of the RI are to determine the nature and extent of contamination at a site, determine the nature and extent of the threat to human health and the environment, and to provide a basis for determining the types of response actions to be considered (Decision Document, Feasibility Study or Focused Feasibility Study, and Remedial Measures, including Remedial Design and Remedial Action).

The RI consists of field activities designed to quantify and identify the potential contaminant, the extent of the contaminant plume, and the pathways of contaminant migration. Field activities may include the installation of soil borings and/or monitoring wells, and the collection and analysis of water, soil, and/or sediment samples. Careful documentation and quality control procedures in accordance with CERCLA/SARA guidelines ensure the validity of data. Hydrogeologic studies are conducted to determine the underlying strata, groundwater flow rates, and direction of contaminant migration.

A baseline risk assessment may be conducted which provides an evaluation of the potential threat to human health in the absence of remedial action. The assessment provides the basis for determining whether remedial action is necessary, justification for performing remedial actions, and what imminent and substantial endangerment to public health or the environment exists.

1.1.4 Feasibility Study (FS)

Based on results of the RI, the baseline risk assessment, and a review of State and Federal regulatory requirements, a FS will be prepared to develop, screen, and evaluate alternatives for remediation of groundwater and/or soil contamination at the subject sites. The overall objective of the FS is to provide information necessary for remedial alternatives development. The FS is conducted to support selection of a remedy that is protective of human health and the environment; attains Applicable or Relevant and Appropriate Requirements (ARARs); satisfies the preference for treatment that significantly and permanently reduces toxicity, mobility, or volume of hazardous constituents as a principal element; and is cost-effective. Activities associated with the FS include the following:

- Development of alternatives;
- Preliminary screening of remedial alternatives;
- Detailed analysis of alternatives;
- Comparative analysis of alternatives; and
- The creation of an FS Report.

The end result of the FS is the selection of the most appropriate remedial action with concurrence by State and/or Federal regulatory agencies.

A focused feasibility study (FFS) might be incorporated in situations where site-specific conditions have been identified and certain technologies have already been considered and screened.

1.1.5 Remedial Measures

The purpose of remedial measures is to develop and implement the appropriate remedial measures to assure a complete remedial action program to protect human health and the environment. These measures are formulated in the design and remedial action phases of the process.

1.1.5.1 Remedial Design (RD)

The RD phase of the process involves formulation and approval of the engineering designs required to implement the selected remedial action(s) identified in the FS.

1.1.5.2 Remedial Action (RA)

The RA is the actual implementation of the remedial alternative. It refers to the accomplishment of measures to eliminate the hazard or, at a minimum, reducing it to an acceptable limit. Covering a landfill with an impermeable cap, pumping and treating contaminated groundwater, installing a new water distribution system, and *in-situ* biodegradation of contaminated soils are examples of remedial measures that might be selected. In some cases, after the RAs have been completed, a long-term monitoring (LTM) system may be installed as a precautionary measure to detect contaminant migration or to document the efficiency of remediation.

EXECUTIVE SUMMARY

ES 1.0 INTRODUCTION

This Report presents the results of the Site Investigation (SI) conducted at Installation Restoration Program (IRP) Site No. 4 (the base drainage ditch) at the 128th Air Refueling Wing (ARW), General Billy Mitchell Field Air National Guard Base (ANGB), Milwaukee, Wisconsin. A Phase I Records Search conducted by R. F. Weston, Inc. (WESTON), in 1984 and the Addendum to the Installation Restoration Program Phase I Records Search conducted by the Hazardous Materials Technical Center (HMTC) in 1986 identified IRP Site No. 4 as a potentially contaminated site. The Phase I Record Search involves review into historic environmental practices at the installation through examination of base records, interviews with long-term personnel, and research on the general environmental setting of the area. The Addendum Phase I Record Search was conducted to update and verify the WESTON report.

The Air National Guard Readiness Center, Environmental Division, Installation Restoration Program Branch (HQ ANG/CEVR) authorized Operational Technologies Corporation (OpTech) to prepare an SI Work Plan and conduct the SI. The SI Work Plan was approved by HQ ANG/CEVR in October 1994, and the SI was conducted according to the Work Plan under the authority of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986.

The following tasks were completed during the SI at General Billy Mitchell Field ANGB:

- Advancing 38 push-sample soil borings (a push-sample is advanced by the use of direct-push technology, which consists of a hydraulic and percussion drive-point system on a truck-mounted unit);
- Advancing four push-sample piezometers;
- Collecting 83 investigation soil samples;
- Installing and developing five new monitoring wells (well development involves the removal of specific volumes of water from the well in order to repair the effect of disturbances to the formation done by the drilling operation so that

natural hydraulic properties are restored and water will flow more freely to the well);

- Measuring water levels and collecting groundwater samples from the five monitoring wells;

- Testing four monitoring wells for hydraulic conductivity using the rising head slug test method; and

- Surveying the locations of all push-sample soil borings, push-sample piezometers, and monitoring wells.

ES 2.0 INVESTIGATIONS AT THE IRP SITE

The base drainage ditch (IRP Site No. 4) is located along the north and west perimeters of the base, and bisects the south half of the installation. The drainage ditch is approximately 1,000 feet in length on the southern side, 2,000 feet in length on the western side, 800 feet on the northern side, and 10 feet wide in most places. Drainage ditch depth is approximately three feet. The majority of IRP Site No. 4 is unpaved, with the exception of a cemented culvert area on the southern side. Potential contaminants include petroleum fuels; therefore, soil and groundwater samples were submitted for analysis of volatile organic compounds (VOCs), total petroleum hydrocarbons (TPH) as diesel range organics (DRO) and gasoline range organics (GRO), polynuclear aromatic hydrocarbons (PAH), and lead.

Two general areas at the base exhibited soil and groundwater concentrations of benzene, toluene, ethylbenzene, and xylenes (BTEX) constituents, DRO, GRO, and lead (groundwater only) above Wisconsin Department of Natural Resources (WDNR) cleanup guidelines: (1) the northernmost section of the drainage ditch, near the outlet to Bailey's Pond, extending west to push-sample location 04-0011PS; and (2) the area adjacent to the southern and southwestern sections of the drainage ditch, extending from the drainage ditch/Chicago & Northwestern Railroad intersection to the area of the new taxiway. In general, higher contaminant concentrations were found at depths greater than 5 feet below land surface (BLS) to the maximum depth of investigation, approximately 20 feet BLS.

The following sources, in order of probable degree of contamination source, have probably influenced contamination near the drainage ditch: (1) a large fuel release from a commercial gasoline pipeline, which flowed onto areas of the base; (2) operations at the petroleum, oil and

lubricants (POL) facility, including underground storage tanks (USTs) storing waste aviation fuel; and (3) impacted stormwater runoff and/or fuel spillage from the aircraft apron.

A large gasoline release occurred at a commercial underground pipeline within the boundary of the base. In 1968, the pipeline (owned by West Shore Pipeline, Inc. (WSPL)) ruptured, releasing up to 600,000 gallons of gasoline onto the base. Between 100,000 and 520,000 gallons of the fuel were reportedly recovered. According to personnel who were present at the base during that period, the fuel drained into the southwest corner of the base. The fuel pooled in an area that was at a lower elevation than the aircraft apron and which consisted of a marshy area with trees, grass, cattails, and brush. The fuel migrated through the drainage ditch and flowed into Bailey's Pond, where it was reportedly recovered. However, no attempt was made to recover the fuel which had drained into the marshy area at the southwest corner of the base.

According to base personnel, small fuel spills of several gallons each have occurred near the POL facility and aircraft apron over the years. A larger spill of 400 gallons of fuel occurred in February 1986, but was completely contained. Another release of an unknown quantity of fuel occurred in March 1986 during a flooding event when a sump malfunctioned, allowing fuel to flow out of the tank and into a concrete drainage channel. Absorbant booms were placed along the drainage channel and were observed to be effective in absorbing the floating fuel. It was concluded that the flooding at the time of the spill would ensure a high dilution factor of any contaminants not recovered. Stormwater runoff from the flightline (where deicing fluids are regularly used) may also be a source of contamination at the base.

ES 2.1 Soil Contamination

The WDNR has established interim soil cleanup guidelines for individual BTEX constituents, GRO, DRO, and lead. These guidelines, contained in Wisconsin Administrative Code, Chapter 720 (NR 720), are mandated by the State's Hazardous Substance Spill Law. The WDNR establishes cleanup levels for contaminants not covered under NR 720 (i.e., PAH and other VOCs) on a site-specific basis.

The most extensive soil contamination was identified in areas adjacent to the southern and southwestern sections of the drainage ditch (IRP Site No. 4) near Buildings 113, 114, and 128. WDNR soil cleanup guidelines for benzene, toluene, ethylbenzene, total xylenes, GRO, and DRO were exceeded in this area. Applicable cleanup levels for soil, and the maximum detected contaminant concentrations in the southern/southwestern portions of the drainage ditch, are compared below:

Maximum Contaminant Concentrations Detected in Soil Near Southern/Southwestern Portions of the Drainage Ditch 128th ARW, General Billy Mitchell Field ANGB, Milwaukee, Wisconsin

Constituent	Standard	Maximum Concentration
Benzene	5.5 μg/kg	25,000 μg/kg
Toluene	1,500 μg/kg	130,000 μg/kg
Ethylbenzene	2,900 μg/kg	68,000 μg/kg
Xylenes	4,100 μg/kg	300,000 μg/kg
Diesel range organics (DRO)	100 mg/kg	1,700 mg/kg
Gasoline range organics (GRO)	100 mg/kg	4,600 mg/kg
Lead	500 mg/kg (industrial sites)	93 mg/kg

μg/kg – micrograms per kilogram.
mg/kg – milligrams per kilogram.

Standards established in Wisconsin NR720.

In the area near Bailey's Pond and the access taxiway, near the north boundary of the base, benzene and DRO exceeded WDNR cleanup levels established for contaminated soils. Benzene was detected at maximum concentrations of 15 μg/kg in soil, and DRO at a maximum of 140 milligrams per kilogram (mg/kg).

In the area near Buildings 107 and 108 at the southeast corner of the aircraft apron, DRO was the only contaminant detected that exceeded WDNR cleanup guidelines. DRO was detected in one sample only at a maximum concentration of 100 mg/kg, which is the established action level for this constituent.

ES 2.2 Groundwater Contamination

The WDNR establishes groundwater protection standards, codified in Wisconsin Administrative Code, NR 140, for individual BTEX constituents, the PAHs benzo(a)pyrene and naphthalene, and lead. There are no WDNR groundwater protection standards for DRO and GRO. The WDNR establishes cleanup levels for contaminants not covered under NR 140 on a site-specific basis.

The most significant contaminant impacts to groundwater were identified in areas adjacent to the southern and southwestern sections of the drainage ditch. Groundwater samples from various sampling points (piezometer 04-003PZ and monitoring well 04-003MW) within this area exhibited BTEX, PAH, or lead concentrations exceeding groundwater protection standards.

These maximum detected concentrations, along with the groundwater protection standards, are shown below:

Maximum Contaminants Detected in Groundwater*
Near Southern/Southwestern Portions of the Drainage Ditch
128th ARW, General Billy Mitchell Field ANGB, Milwaukee, Wisconsin

Constituent	Standard	Maximum Concentration
Benzene	5 μg/L	7,200 μg/L
Toluene	343 μg/L	32,000 μg/L
Ethylbenzene	700 μg/L	4,100 μg/L
Xylenes	620 μg/L	21,000 μg/L
Naphthalene	40 μg/L	518.3 μg/L
Lead	15 μg/L	410 μg/L

μg/L – micrograms per liter. Standards established in Wisconsin NR140.
* – Confirmation sample analyses.

The results of screening and confirmation sample analyses were similar in magnitude.

In the area near Bailey's Pond and the access taxiway, a maximum total lead concentration of 290 micrograms per liter (μg/L) was detected in a screening sample from piezometer 04-002PZ. However, confirmation groundwater samples, collected from the nearest monitoring well to the area (04-002MW) approximately 90 feet south of piezometer 04-002PZ, did not exhibit detectable levels of lead.

Benzo(a)pyrene and lead were detected above WDNR groundwater protection levels in groundwater screening samples collected from piezometer 04-004PZ, located near the reported West Shore Pipeline spill. Benzo(a)pyrene was detected at a concentration of 3.02 μg/L, and lead was detected at 170 μg/L. No other groundwater contaminants exceeding WDNR protection standards were detected in this area. Concentrations of various PAH ranging up to 15,300 μg/kg in soil samples were detected in push-sample location 04-025PS, located in the same area.

In conformance with the SI Work Plan, no groundwater sampling was conducted from the push-sample locations in the area near Buildings 107 and 108.

ES 3.0 RECOMMENDATIONS

Based on the results of this SI, the following recommendations are presented:

- Remedial investigation (RI) work, including the installation of additional monitoring wells and drilling of soil borings, is needed to further delineate contaminant-impacted soil and groundwater along the drainage ditch in the southern and southwestern area of the base and in the area of Bailey's Pond. Additionally, monitoring wells should be installed along the west and northwest edge of the base to determine both the horizontal and vertical extent of contamination.

- A background sampling program should be undertaken in areas away from known or suspected sources of contamination in order to determine background soil and groundwater conditions in the area.

- Additional investigation is recommended to evaluate potential sources of the DRO contamination detected in soils near Buildings 107 and 108, which appears unrelated to IRP Site No. 4. Potential contaminant sources are the POL facility and the aircraft apron.

SECTION 2.0 FACILITY BACKGROUND

General Billy Mitchell Field ANGB consists of three different parcels of property. The primary location of the base contains a northern portion occupying 58.5 acres and a southern portion occupying 46.5 acres. A small western section of the base, the former location of the Tactical Control Flight (TCF) Unit, occupies approximately five acres and is located west of the main north-south airport runway. The primary base area and the former TCF area are shown on Figure 2.1. The 128th ARW is located at NW quadrant, Section 34, Township 6N, Range 22E, Milwaukee (Milwaukee County). Wisconsin. The base, located within the city limits of Milwaukee, is approximately 15 miles southwest of downtown and approximately 2.5 miles west of Lake Michigan. For ease of reference, the 128th ARW facilities at the airport are collectively referred to as the "base."

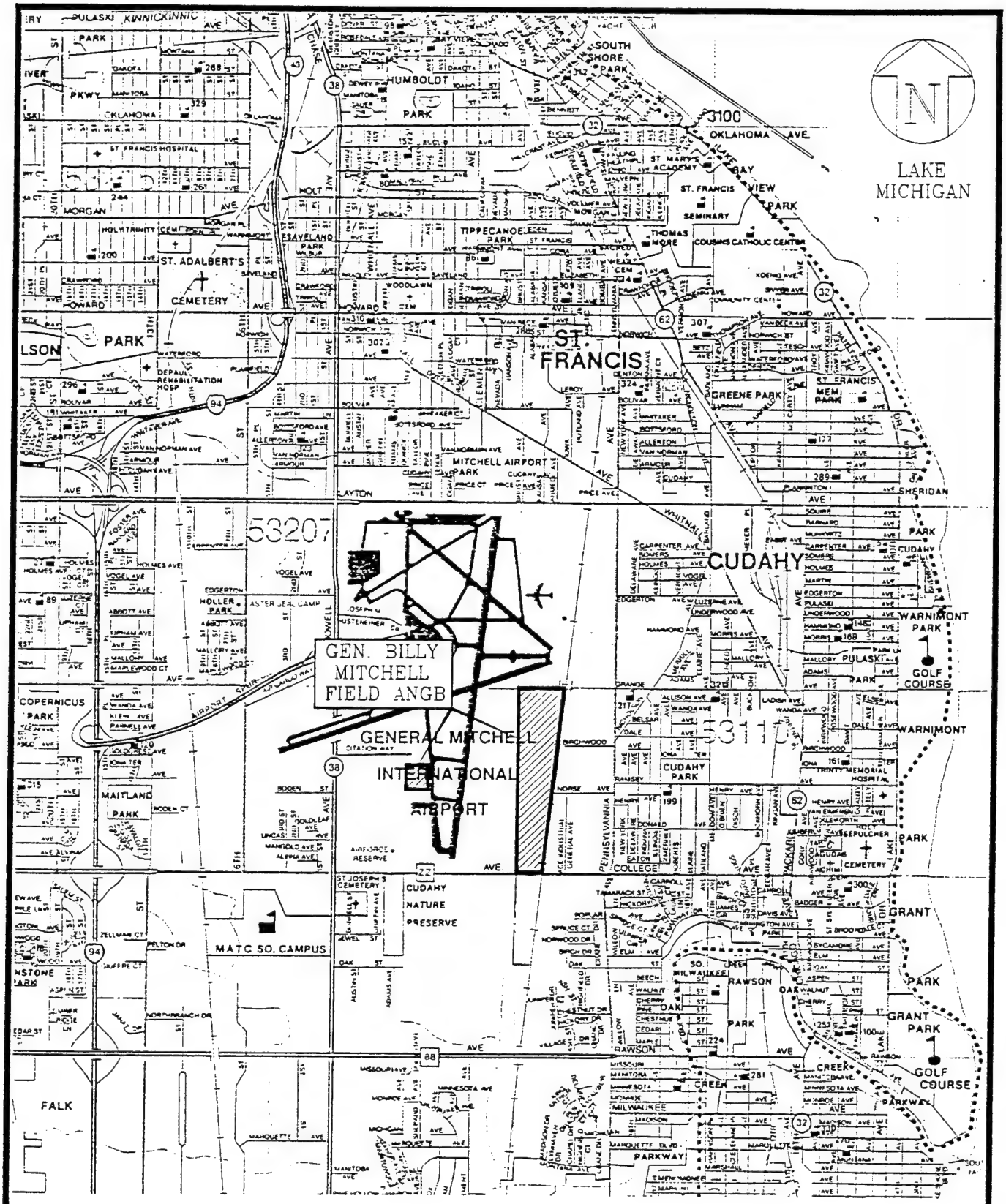
The northern portion of the base consists of a main building for administration activities, smaller buildings associated with storage of equipment or vehicle maintenance, an aircraft apron, and parking. The southern portion of the base is covered with vegetation and was the location of a former landfill used by the City of Milwaukee. The base has a normal weekday working population of approximately 300 and a population of 987 during training weekends.

2.1 FACILITY HISTORY

The 128th ARW at General Billy Mitchell Field ANGB was first established at the General Mitchell International Airport in 1947. Originally, the mission of the base was to fly F-51D Mustang fighter aircraft. The current facility was constructed in 1962 when the mission of the base was changed to flying KC-97 Air Refueling aircraft. Additional buildings were constructed to accommodate the increase in personnel, supplies, and aircraft.

The current mission of the base involves flying the KC-135 Air Refueling aircraft. Designed to refuel bomber aircraft on long-range missions, the KC-135 is capable of carrying larger quantities of fuel than the KC-97. In order to accommodate the increased quantities of fuel stored, the base was expanded. An underground hydrant system was installed underground to provide a more efficient method of fueling the mission aircraft.

The southern portion of the base is occupied by a landfill previously owned by the City of Milwaukee. The landfill was used from 1940 until 1985 (HMTC, 1986). Material disposed in the landfill included scrap metal, construction debris, and leaves. According to the 128th ARW Environmental Management Office, the landfill has not "officially" been closed by the State.



SOURCE: Modified from Rand-McNally

FIGURE 2.1

BILLYMIT\LOC-MAP

LOCATION MAP

128th ARW, Gen. Billy Mitchell Field ANGB

Milwaukee, Wisconsin

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2.1.1 Waste Disposal Practices

Present and past Air National Guard (ANG) activities at General Billy Mitchell Field ANGB involved the use of hazardous materials and the disposal of potentially hazardous wastes. The sources of most of these hazardous materials/wastes can be associated with the following activities:

- Industrial shop operations;
- Hazardous waste storage areas;
- Fuels management; and
- Spills.

Products used by the 128th ARW include fuels for aircraft and ground vehicles, heating oil, ethylene glycol, solvents, battery acids, and paint thinners.

The base is a small quantity generator of hazardous waste. Hazardous waste, generated in the maintenance hangars and base motor pool, is stored at satellite accumulation points and transferred to a central collection point for proper disposal. Hazardous waste is removed by the Defense Reutilization and Marketing Office (DRMO) or by contractors.

2.1.2 Previous Investigations

The Phase I Records Search conducted by WESTON in 1984 identified eight sites of environmental concern. Five sites were identified at the Air Force Reserve Facility (440th Tactical Airlift Wing (TAW)), which is located on the east side of the main airport runway, and three sites were identified at the 128th ARW. The recommendations identified four sites, all located at the Air Force Reserve Base, as having the potential for environmental contamination. The three sites located at the 128th ARW were the Past Storage Area, the Solvent Storage Tank, and the Disposal Area I. These sites were not identified as having potential for environmental concern.

An Addendum to the Phase I Records Search was prepared by HMTC in November 1986. The purpose of the Addendum was to update the 1984 WESTON report, and to verify the data contained in the original Phase I Records Search (WESTON, 1984). In addition to the three sites identified in the 1984 WESTON report, HMTC identified five additional areas of environmental concern at the 128th ARW. These sites include a drainage ditch near the petroleum, oils and lubricants (POL) facility, two locations at the Vehicle Maintenance Shop,

an inactive rubble landfill, and an underground storage tank (UST). The selection of the drainage ditch as a site of concern was due to the two fuel spills which flowed into the ditch since 1984. On 20 February 1986, a JP-4 fuel spill of 400 gallons occurred at the POL facility. The spill was contained within the concrete diked area of the tank farm, with no loss of contaminants to the environment. On 11 March 1986, during a flooding event, another JP-4 fuel release occurred when a sump, which prevents overflows from the POL spill retention tank, malfunctioned. An unknown quantity of JP-4 flowed out of the tank and into a concrete drainage channel. Absorbent booms were placed at three points along the drainage channel and were observed to be effective in absorbing the floating POL. The HMTC report concluded that the flooding at the time of the spill would ensure a high dilution factor of any contaminants not recovered.

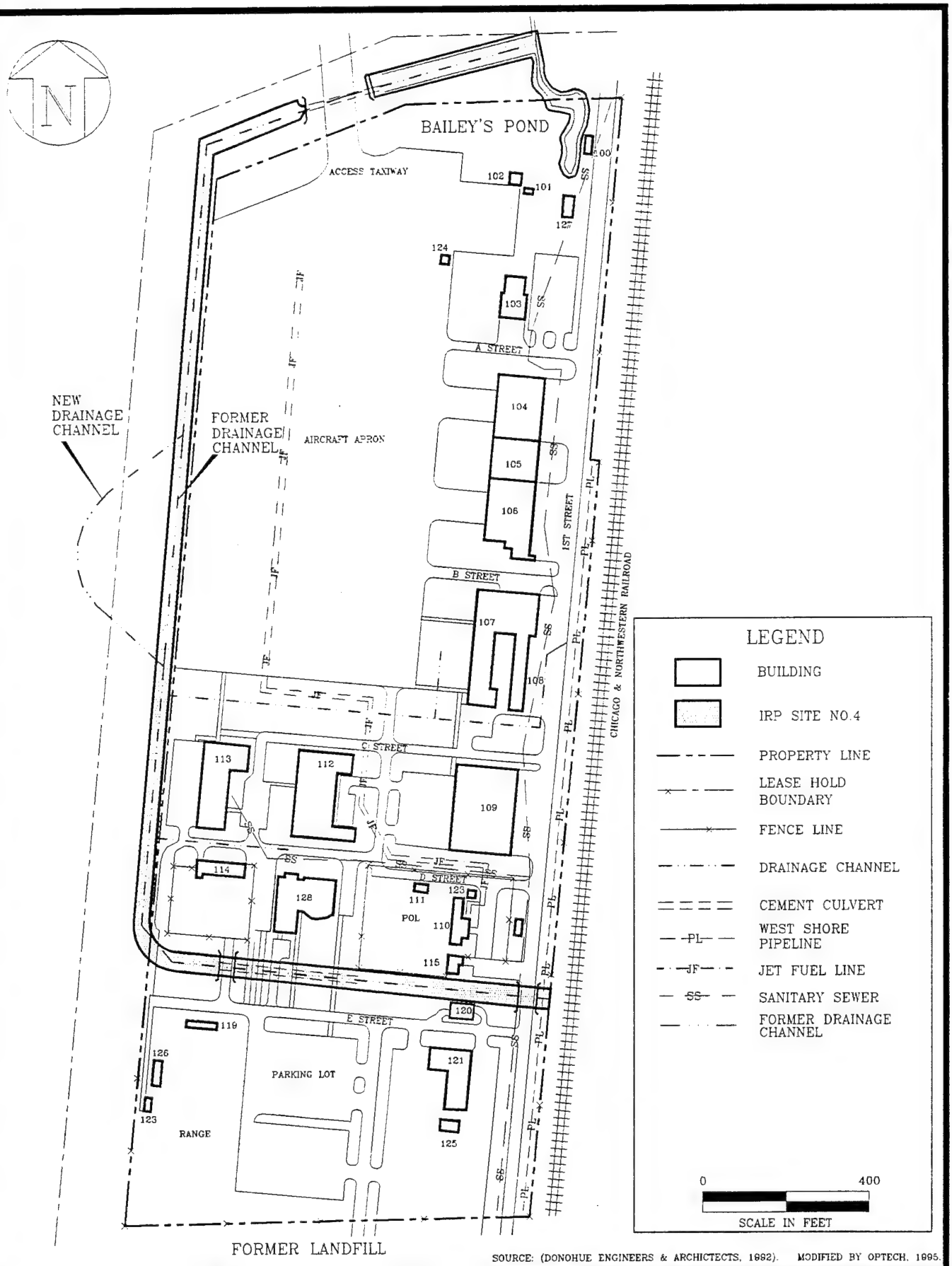
The 1984 WESTON report did not identify hazardous waste activities at the 128th Tactical Control Flight (TCF) portion of the base. The 1986 Addendum to the Phase I Records Search included hazardous-waste-related activities at the 128th TCF portion of the base; however, the Addendum did not identify any sites at the former TCF portion of the base as areas of environmental concern. Since 1986, the TCF unit has relocated away from the General Billy Mitchell Airport property (HMTC, 1986).

2.2 SITE DESCRIPTION

2.2.1 IRP Site No. 4 (Base Drainage Ditch)

IRP Site No. 4 is located along the north and west perimeters of the base, and bisects the south half of the base (see Figure 2.2). The drainage ditch is approximately 1,000 feet in length on the southern side, 2,000 feet in length on the western side, 800 feet in length on the northern side, and 10 feet wide in most places. The depth of the ditch is approximately three feet. The majority of the site is unpaved, with the exception of a cemented culvert area on the southern side (see Figure 2.2).

Near the western boundary of the base, the drainage ditch exits base property and enters City property occupied by General Mitchell International Airport. At this point, surface water flows north and ultimately drains into Bailey's Pond, located in the northeast corner of the base. Recently, the original surface drainage was diverted near the new taxiway (Figure 2.2). Clean fill was used to backfill the section of drainage ditch which was abandoned.



SOURCE: (DONOHUE ENGINEERS & ARCHICTECTS, 1982). MODIFIED BY OPTECH, 1995.

FIGURE 2.2

BILLYMIT\BASEMAP

IRP SITE LOCATION MAP

128th ARW, Gen. Billy Mitchell Field ANGB
Milwaukee, Wisconsin

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2.2.1.1 History of Activities

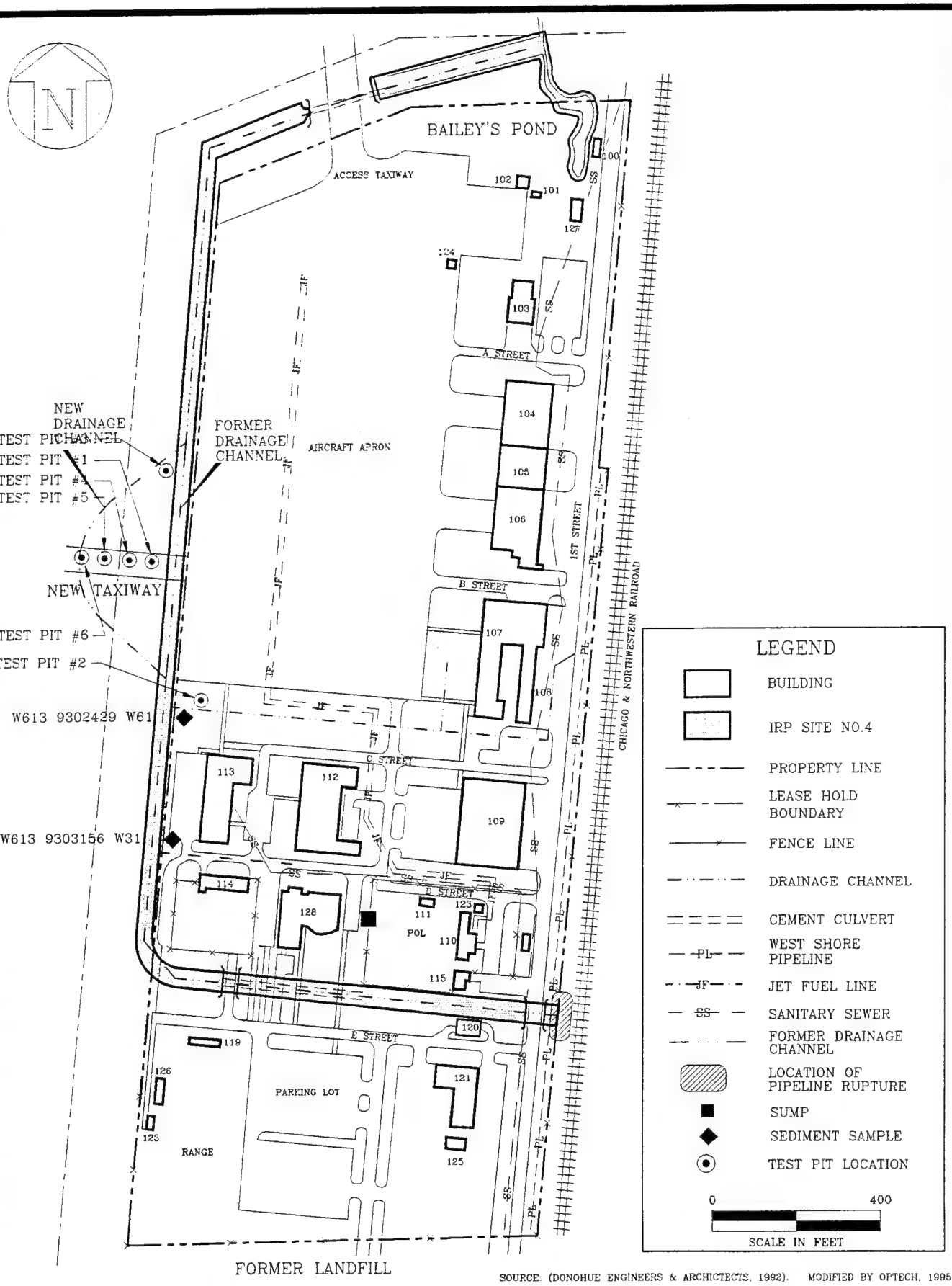
The existence of contamination at IRP Site No. 4 was confirmed during construction activities conducted in August 1992 and Spring 1993, when petroleum hydrocarbons were encountered in the subsurface soils. The construction activities occurred in the area of the aircraft apron and along the base drainage ditch near the western boundary of the base. Figure 2.3 shows the areas of contamination identified during construction activities. Soil samples from the test pit locations were analyzed using field screening instruments. Test pit results, expressed as total volatile organic compounds (VOCs), ranged from less than 10 milligrams per kilogram (mg/kg) to 2,000 mg/kg. Table 2.1 presents the results of the analysis.

Table 2.1
Test Pit Field Screening Results
128th ARW, General Billy Mitchell Field ANGB, Milwaukee, Wisconsin

Test Pit Number	Depth (ft BLS)	VOCs (mg/kg)
1	13	800
2	8	200
3	14	2,000
4	8	<10
5	8	<10
6	8	30 - 190

ft BLS – feet Below Land Surface. mg/kg – milligrams per kilogram.
VOCs – Volatile Organic Compounds.

Two soil samples were collected for laboratory analyses from two sampling locations shown on Figure 2.3. One sampling location (W613 9302429 W61) is near the western boundary of the base, between the aircraft apron and Building 113, and the second sample location (W613 9303156 W31) is southwest of Building 113. Sample results for these two sampling locations are presented in Table 2.2. The highest VOC levels were total xylenes, which ranged from 100-160 mg/kg; benzene concentrations ranged from 1.2 to 7.8 mg/kg. Gasoline range organics (GRO) were detected at a concentration of 1,400 mg/kg at sampling location W613 9303156 W31; GRO were not analyzed in soil from sampling location W613 9302429 W61. Diesel range organics (DRO) were detected at concentrations of 54 mg/kg at sampling location W613 9302429 W61 but were not analyzed for in soil from sampling location W613 9303156 W31. Polynuclear aromatic hydrocarbons (PAH) were detected in soil from sampling location W613 9303156 W31, with the highest level detected being naphthalene at 840 micrograms per kilogram (μg/kg); sampling location W613 9302429 W61 had few detections with the highest level detected being naphthalene at 880 μg/kg. Lead concentrations



SOURCE: (DONOHUE ENGINEERS & ARCHICTECTS, 1992). MODIFIED BY OPTECH, 1995.

FIGURE 2.3

BILLYMIT\BASEMAP

PREVIOUS SAMPLING LOCATION MAP

128th ARW, Gen. Billy Mitchell Field ANGB
Milwaukee, Wisconsin

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Table 2.2
1993 Soil Sampling Analysis Results
128th ARW, General Billy Mitchell Field ANGB, Milwaukee, Wisconsin

Analyte	Results	
	Sample: W613 9303156 W31	Sample: W613 9302429 W61
VOCs by SW8020 (mg/kg)		
Methyl T-Butyl Ether	<1.2	<0.12
1,3,5-Trimethyl Benzene	17	12
1,2,4-Trimethyl Benzene	54	37
Benzene	<1.2	7.8
Ethylbenzene	35	17
Toluene	69	52
Total Xylenes	160	100
TPH by WDNR GRO/DRO (mg/kg)		
Gasoline Range Organics	1,400	1,200
Diesel Range Organics	NA	54
PAH by SW8310 (µg/kg)		
1-Methylnaphthalene	160	170
2-Methylnaphthalene	470	570
Naphthalene	840	880
Acenaphthene	<89	<89
Anthracene	<32	<32
Fluoranthene	100	<10
Fluorene	<10	<10
Pyrene	63	<14
Benzo(a)anthracene	33	<0.64
Benzo(a)pyrene	36	<1.1
Benzo(b)fluoranthene	32	<0.89
Benzo(k)fluoranthrene	15	<0.84
Chrysene	38	<7.4
Dibenzo(ah)anthracene	11	<1.5
Indeno(123-cd)pyrene	27	<2.1
Acenaphthylene	<110	<110
Benzo(ghi)perylene	12	<3.7
Phenanthrene	100	<32
Lead by SW6010 (mg/kg)		
Lead - Total	NA	10

VOCs – Volatile Organic Compounds.
TPH – Total Petroleum Hydrocarbons.
PAH – Polynuclear Aromatic Hydrocarbons.
mg/kg – milligrams per kilogram.
µg/kg – micrograms per kilogram.

WDNR GRO/DRO – Wisconsin Department of Natural Resources Gasoline Range Organics/Diesel Range Organics.
NA – Not Analyzed.

were 10 mg/kg at the sampling location W613 9302429 W61, and lead was not analyzed in soil from sampling location W613 9303156 W31. Based on the analytical results of these test pit and soil sampling activities, the base drainage ditch was recommended for further IRP investigation.

2.2.1.2 Potential Release Sources

Two USTs, a 1,500-gallon oil/water separator (OWS) and a 2,000-gallon UST used to store waste jet fuel, are currently in use at the base. Table 2.3 presents an inventory list of the current and former USTs located at the base. Prior to their removal, two USTs (No. 114-3 and 114-4) failed tightness tests; however, preliminary analytical results indicated that the two tanks do not appear to be the source of contamination detected near the southeast corner of Building 114. Figure 2.4 shows the location of the current and former USTs at the base.

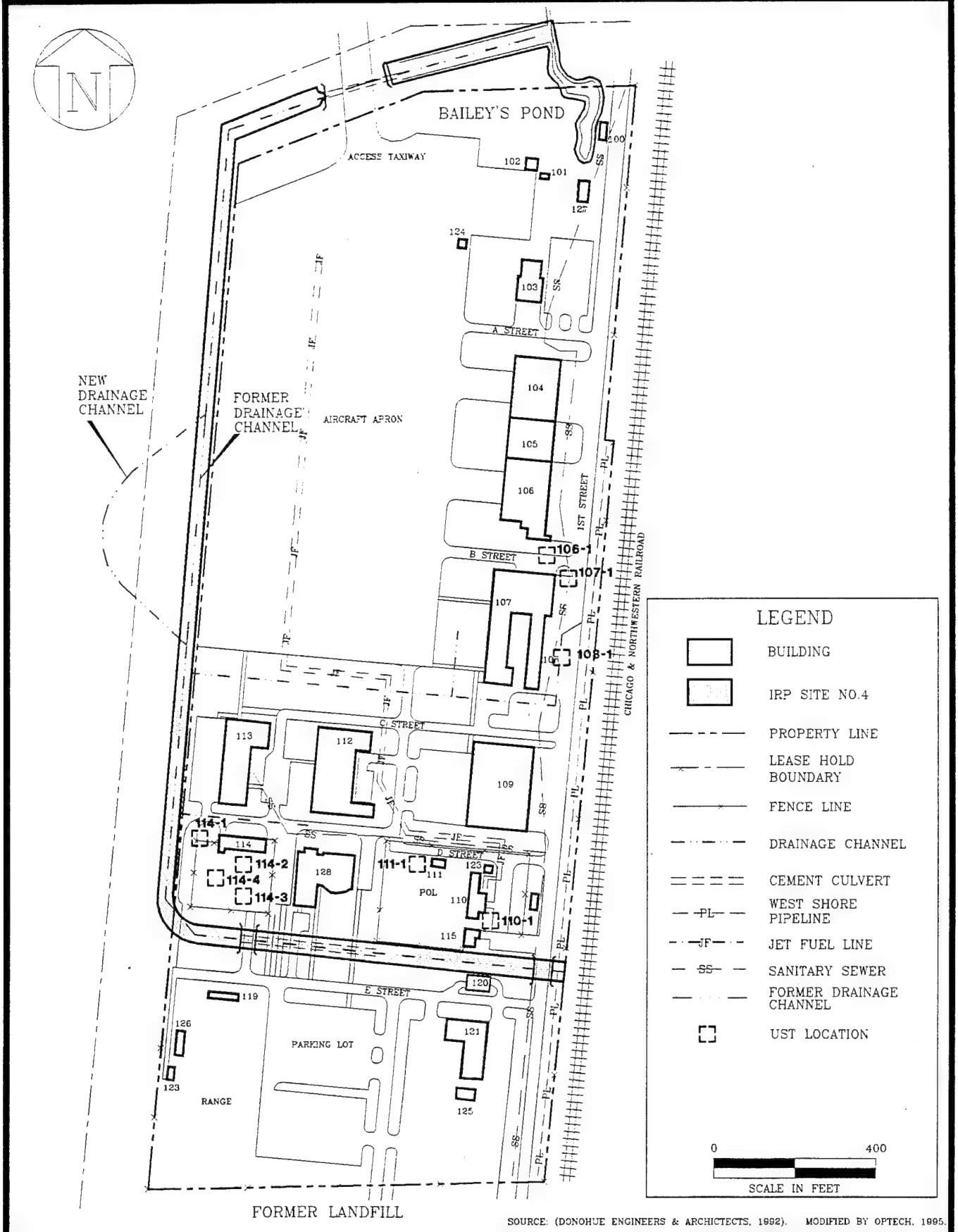
Table 2.3
Underground Storage Tank Inventory
128th ARW, General Billy Mitchell Field ANGB, Milwaukee, Wisconsin

Tank Number	Capacity (gallons)	Product	Status (Current)	Tank Type	Construction
106-1	15,000	Heating Oil	Removed	UST	N/A
108-1	550	Waste Oil	Removed	UST	Coated Steel
114-1	550	Waste Oil	Removed	UST	Coated Steel
114-2	6,000	Diesel	Removed	UST	N/A
114-3	10,000	Gasoline	Removed	UST	N/A
114-4	6,000	Diesel	Removed	UST	N/A
107-1	550	Waste Oil	Removed	UST	Coated Steel
110-1	2,000	Jet Fuel	In use	UST	Coated Steel
111-1	1,500	Jet Fuel	In use	OWS	Coated Steel

N/A – Not Applicable.

OWS – Oil/Water Separator.

A large gasoline release occurred at a commercial underground pipeline located near the eastern perimeter and within the boundary of the base. In 1968, the pipeline (owned by West Shore Pipeline, Inc. (WSPL)) ruptured, releasing approximately 600,000 gallons of gasoline onto the base (Huelsman, 1993a). Approximately 200,000 gallons of the fuel were reportedly recovered or evaporated. The location of the pipeline spill was along the western side of the railroad tracks near the intersection of E Street and 1st Street (Huelsman, 1995). The location of the pipeline rupture is identified in Figure 2.3.



SOURCE: (DONOHUE ENGINEERS & ARCHICTECTS, 1992). MODIFIED BY OPTECH, 1995.

FIGURE 2.4

BILLYMIT\BASEMAP

UNDERGROUND STORAGE TANK LOCATION MAP

128th ARW, Gen. Billy Mitchell Field ANGB
Milwaukee, Wisconsin

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2.2.1.3 Potential Release Receptors

Impacts to human health, safety, welfare and the environment are suspected to be minimal. Base workers may be exposed to shallow soil contamination and require the wearing of protective clothing and/or equipment at any such contaminated areas. Additionally, base access is restricted to authorized personnel.

Past environmental reports (HMTC, 1986; Huelsman, 1993a) suggest that impact on private drinking water wells is considered minimal, since groundwater flow is directed toward the northwest, and residential areas are located to the east of the base, approximately 2,000 to 3,000 feet distant. Additionally, municipal water supply is available to most residents in the area. No municipal water supply wells are located in the vicinity of the base. Groundwater samples, collected in December 1995 from four domestic water wells located at residences near the northeast corner of the base, were analyzed for contaminants, and the results are discussed in Section 3.4.

Referenced material indicates that, on a regional basis, the most shallow aquifer underlying the area (the sand and gravel aquifer, which is not commonly used for potable water) and the dolomite aquifer (the Niagara Aquifer, which is the most widely used aquifer) are hydraulically interconnected. Previous investigations and the results of the SI field work indicate localized layers of clay separating the sand and gravel aquifer from the underlying Niagara Aquifer that may inhibit the vertical migration of contaminants where present. These clay layers, however, appear to be discontinuous across the base. The sand and gravel aquifer is particularly susceptible to pollution from overlying land uses, and pollution of the Niagara Aquifer has occurred in heavily urbanized areas of southeastern Wisconsin (Southeastern Wisconsin Regional Planning Commission, 1986, and WESTON, 1984).

A high potential exists for contaminant impact to Bailey's Pond, a marshy area near the northern boundary of the base, by surface runoff directed to the pond by the drainage ditch system at the base. Bailey's Pond and the locations of area surface water bodies near the base are discussed further in Section 3.0.

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SECTION 3.0 ENVIRONMENTAL SETTING

The environmental setting of General Billy Mitchell Field ANGB is presented through discussions of physiography, climate, geology, soils, hydrogeology, surface water and critical habitats/endangered species/wetlands. These discussions incorporate both regional and local perspectives.

3.1 PHYSIOGRAPHY AND CLIMATE

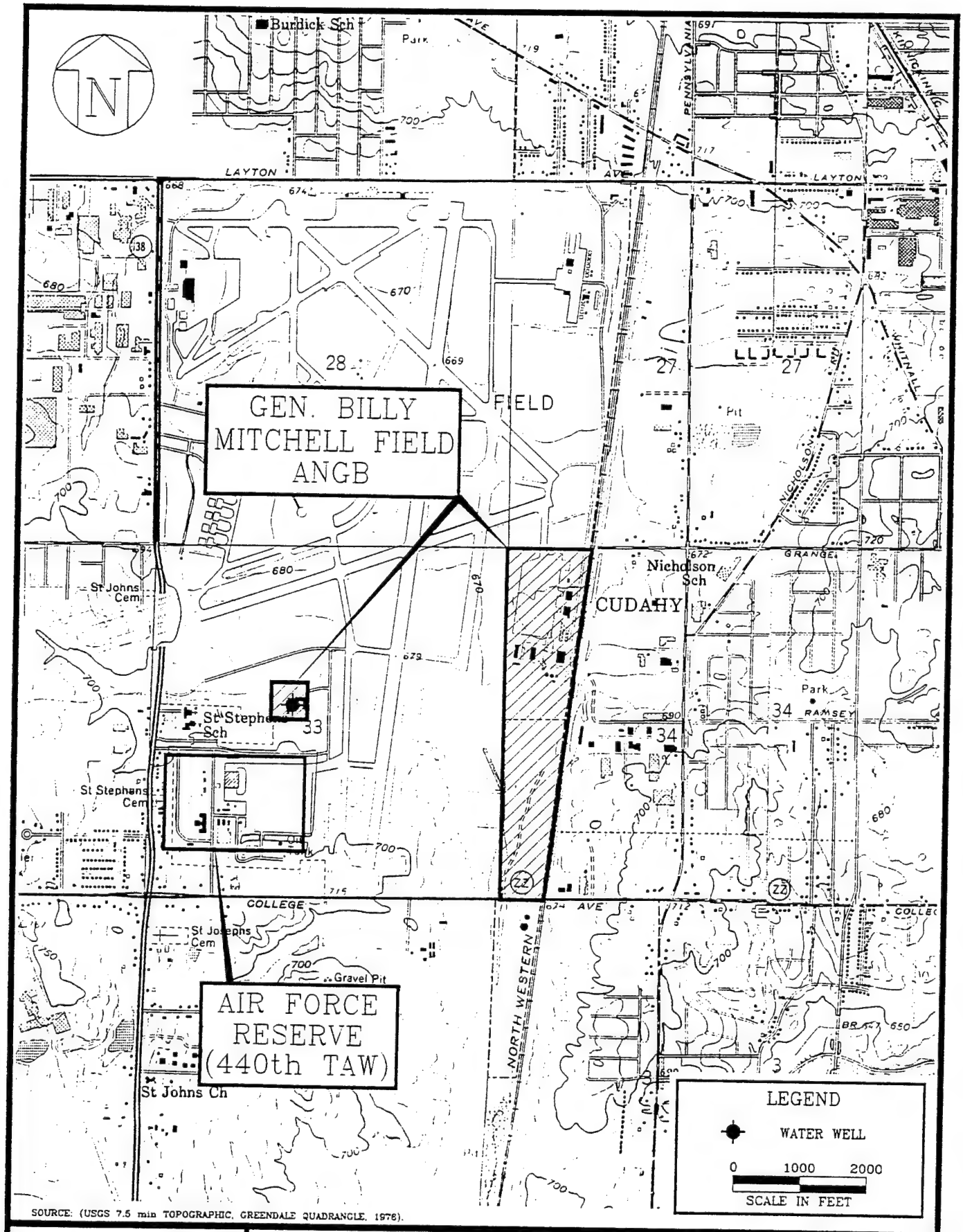
Wisconsin is located in the northern United States, within the Lake Michigan Basin, and borders the western shore of Lake Michigan. There are three physiographic regions in Wisconsin. In the north is the Superior Upland. In the south are two parts of the Central Lowlands, the Great Lakes Plain in the east, and the Wisconsin Driftless Area in the west. The base is located in the Great Lakes Plain region. Surface topography surrounding the base is relatively flat. The elevation at General Billy Mitchell Field ANGB is approximately 670 feet above mean sea level (MSL) (see Figure 3.1).

The climate in Milwaukee County is influenced by Lake Michigan. Northeasterly winds off the lake affect the climate in the spring and early summer. Average daily temperatures in the spring and summer range from 45.4° F to 70.8° F. Heaviest rainfall occurs during the months of May through August, with average monthly precipitation over 3.0 inches. Annual precipitation, based on a 29-year record from 1961-1990, averages 32.93 inches. Evapotranspiration in the Milwaukee area is close to 35 inches per year, resulting in a net annual precipitation deficiency of 2.07 inches (National Oceanic and Atmospheric Administration, 1991).

During winter months, prevailing winds are westerly. Most of the precipitation occurs as snowfall during the winter months (11.8 inches) as a result of decreasing temperatures. The maximum average snowfall occurs in January. Average daily temperatures in the winter range from 20.7° F to 36.4° F. From November until early April, frost penetrates the soils to depths of 36 inches or more (National Oceanic and Atmospheric Administration, 1991).

3.2 REGIONAL AND LOCAL GEOLOGY

During the Pleistocene ice age (8,000 to 2-3 million years ago), great ice sheets from the north spread over the Central Lowlands as far south as the present day Ohio and Missouri rivers. The glaciers moved across the Lake Michigan basin from north and east, scouring rocks and transporting rock debris in the ice. Most of the existing landscape was obliterated by the



SOURCE: (USGS 7.5 min TOPOGRAPHIC, GREENDALE QUADRANGLE, 1976).

FIGURE 3.1

BILLYMIT\75TOPO

TOPOGRAPHIC MAP

128th ARW, Gen. Billy Mitchell Field ANGB
Milwaukee, Wisconsin

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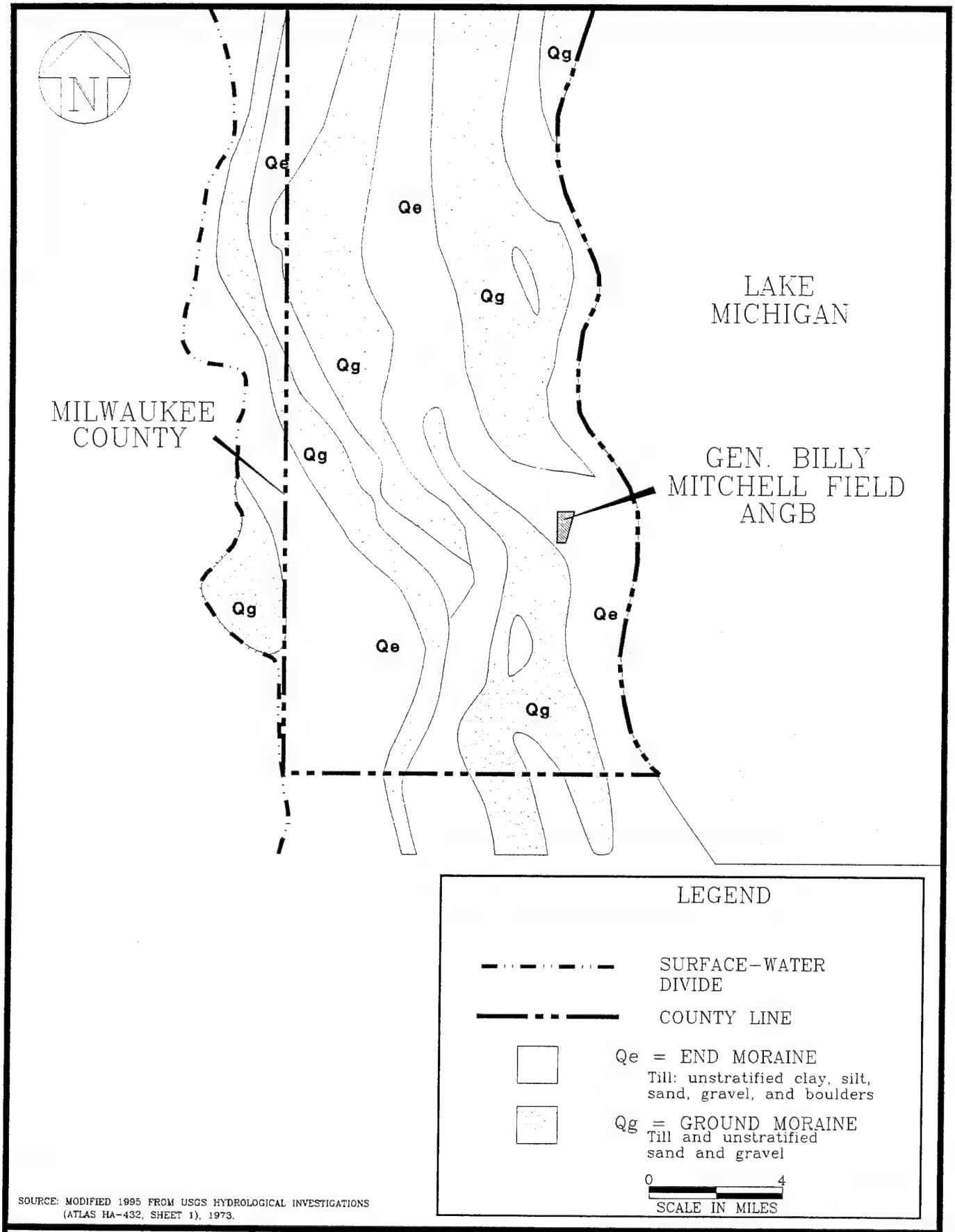
glaciers and buried beneath a thick layer of sand, clay, and gravel called "drift" (United States Geological Survey (USGS), 1973). These sediments consist of stratified outwash and glacial lake deposits of primarily clayey silty till with lens of stratified sand and gravel.

The geology of the Milwaukee area is characterized by thick Paleozoic rocks overlain by deposits of sediment consisting of unsorted till, which was deposited as ground and end moraines, and of sorted and stratified outwash and glacial lake deposits. End moraines form discontinuous bands of hills paralleling Lake Michigan and, in the eastern part of the Lake Michigan basin, they consist primarily of till. Ground moraines, which consist of the material deposited from a glacier on the ground surface over which the glacier has moved, is bordered by lateral and/or end moraines. End moraines mark the terminal position of a valley glacier. Figure 3.2 shows a glacial geologic map of southeastern Wisconsin. Unconsolidated deposits range in thickness from 80 to 140 feet, below which the bedrock is encountered. The area bedrock is composed of Silurian age dolomite. Figure 3.3 shows a bedrock geologic map of eastern Wisconsin, and Figure 3.4 shows a generalized stratigraphic column of the subsurface in the area of the base (USGS, 1973).

The shallow stratigraphy at the base is comprised of glacial deposits. In general, three lithologic units, consisting of either fill material or organic material ranging in thickness of up to 5.5 feet, overlie a clay unit with an average thickness of 2.5 feet. At an average depth of 7 feet below land surface (BLS), a sand unit is encountered that extends to a depth of at least 25 feet BLS. These general lithologic units are locally comprised of smaller subunits of clay, clayey sand, silt, and sand (USGS, 1973, and Southeastern Wisconsin Regional Planning Commission, 1986).

3.3 SOILS

Soils at the base are classified as Clayey land (Cv) by the Soil Conservation Service, 1971. A soil map in Figure 3.5 shows the distribution of soil types surrounding the base. Clayey land is a miscellaneous land type consisting of fill areas and "cut" or "borrow" areas. Ranging from clay to silty clay loam, this land type is approximately one to five feet thick and may include scattered glacial till. The southern portion of the base includes a former city rubble landfill, which contains miscellaneous construction debris and non-hazardous materials such as cans, bottles, and scrap metal.



SOURCE: MODIFIED 1995 FROM USGS HYDROLOGICAL INVESTIGATIONS (ATLAS HA-432, SHEET 1), 1973.

FIGURE 3.2

BILLY\GLACIAL

GLACIAL GEOLOGY IN THE MILWAUKEE COUNTY, WISCONSIN AREA

128th ARW, Gen. Billy Mitchell Field ANGB
Milwaukee, Wisconsin

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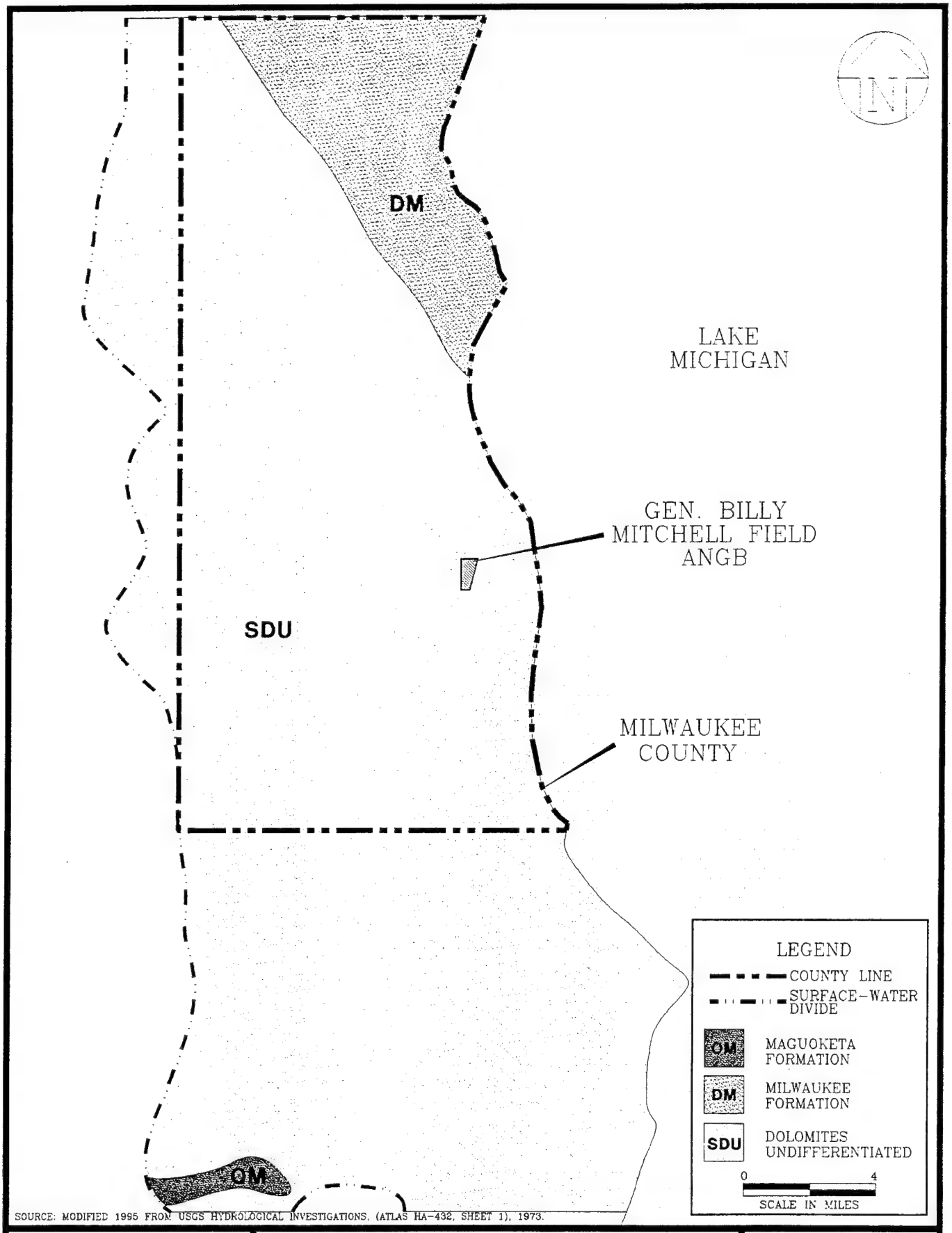

FIGURE 3.3

BILLY\BEDROCK

BEDROCK GEOLOGY IN THE
MILWAUKEE COUNTY, WISCONSIN AREA
128th ARW, Gen. Billy Mitchell Field ANGB
Milwaukee, Wisconsin

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SYSTEM	GEOLOGIC UNIT	YEARS BEFORE PRESENT	NOMINAL THICKNESS OR THICKNESS RANGE (FT)	DOMINANT LITHOLOGY	AQUIFER[a]
QUATERNARY UNCONFORMITY	HOLOCENE AND PLEISTOCENE DEPOSITS	25,000	80–140	CLAY, SILT, SAND, AND GRAVEL AND BOULDERS; POSSIBLY LOCALLY STRATIFIED	SAND AND GRAVEL AQUIFERS (UNCONFINED)
SILURIAN	DOLOMITE UNDIFFERENTIATED	435 MILLION	50–300	DOLOMITE	NIAGARA AQUIFER (UNCONFINED)
ORDOVICIAN	MAQUOKETA SHALE	505 MILLION	200	SHALE	CONFINING BED; NOT AN AQUIFER
	GALENA DOLOMITE, DECORAH FORMATION, & PLATTEVILLE FORMATION, UNDIFFERENTIATED		250	DOLOMITE	ARTESIAN AQUIFER
	ST. PETER SANDSTONE		150–200	SANDSTONE	SANDSTONE AQUIFER (CONFINED)
CAMBRIAN	SANDSTONE UNDIFFERENTIATED	570 MILLION	800+	SANDSTONE	–

THE COMBINATION OF THE UNCONFINED SAND AND GRAVEL AND DOLOMITE AQUIFER IS SOMETIMES REFERRED TO AS THE SHALLOW AQUIFER, AND THE CONFINED SANDSTONE IS SOMETIMES REFERRED TO AS THE DEEP AQUIFER.

SOURCES: (1) USGS, HYDROLOGICAL INVESTIGATIONS (ATLAS HA-432). 1973.
(2) A COMPREHENSIVE PLAN FOR THE OAK CREEK WATERSHED, 1986.

FIGURE 3.4

BILLYMIT\GENSTRAT

GENERALIZED STRATIGRAPHIC COLUMN FOR MILWAUKEE COUNTY, WISCONSIN

128th ARW, Gen. Billy Mitchell Field ANGB
Milwaukee, Wisconsin

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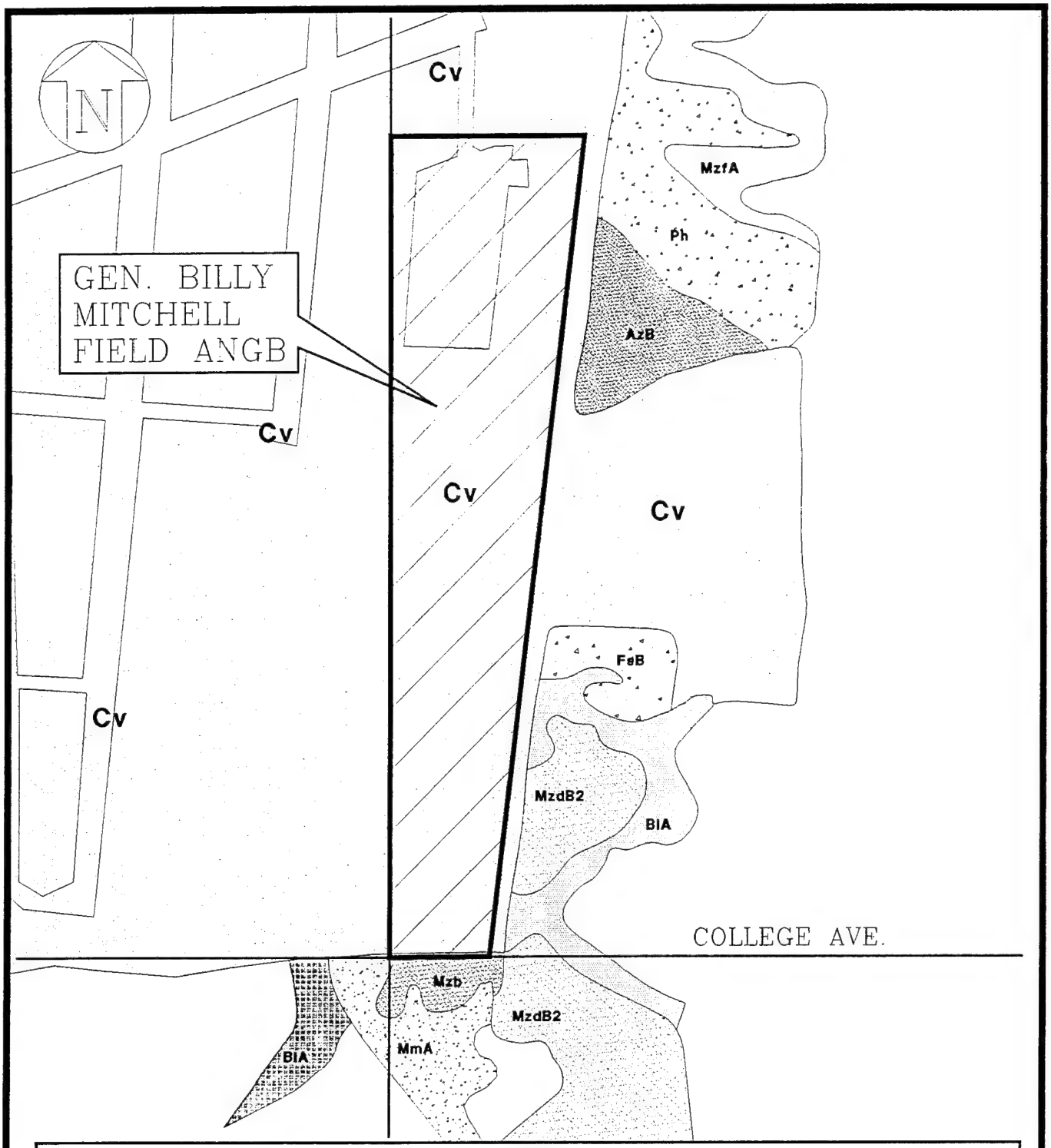

LEGEND

MzfA	MUNDELEIN SILT LOAM	Cv	CLAYEY LAND
Ph	PELLA SILT LOAM	Mzb	MONTGOMERY SILTY CLAY LOAM
BlA	BLOUNT SILT LOAM	AzB	AZTALAN LOAM
MzdB2	MORLEY SILT LOAM	FsB	FOX SILT LOAM
MmA	MATHERTON SILT LOAM		ANGB BOUNDARY

0 1000
SCALE IN FEET

SOURCE: (SOIL CONSERVATION SERVICE, 1971). MODIFIED BY OPTECH, 1995.

FIGURE 3.5

BILLYMIT\SOILMAP

SOIL MAP
128th ARW, Gen. Billy Mitchell Field ANGB
Milwaukee, Wisconsin

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3.4 HYDROGEOLOGY

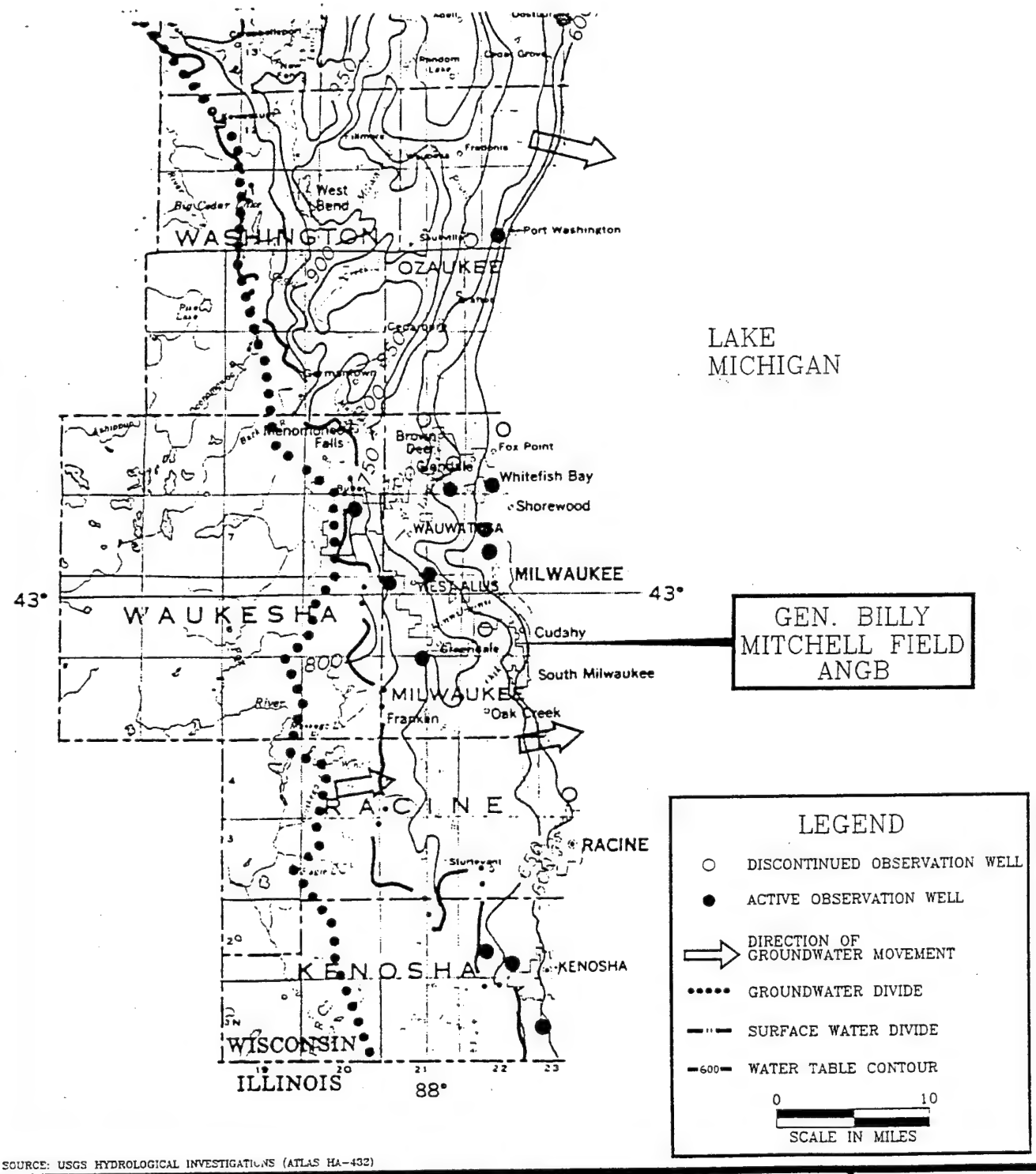
Regionally, the general direction of groundwater flow of the water table aquifer is to the east toward Lake Michigan (USGS, 1973) (Figure 3.6). Groundwater in the basin moves within the water table system above the Maquoketa Shale and in the artesian system, which is confined beneath the Maquoketa Shale.

During this SI, groundwater was encountered at shallow depths, ranging between 5 to 10 feet BLS, in monitoring wells installed at the base. During this investigation and another investigation conducted by the 128th ARW Environmental Management Office in 1993, the general direction of groundwater flow at the base was to the northwest. Based on the aquifer slug tests performed during this investigation, hydraulic conductivity is estimated to range from 16.65 to 301.1 gallons/day/foot^2 (7.85×10^{-6} to 1.42×10^{-4}cm/sec).

Limestone and dolomite bedrock underlie the glacial deposits in the area, and most of the water wells in the area are completed within a shallow aquifer composed of a dolomite unit (the Niagara Aquifer). According to A Comprehensive Plan for the Oak Creek Watershed, the upper sand and gravel aquifer (glacial deposits) is in hydraulic connection with the underlying dolomite Niagara Aquifer. The prevalence of localized thick layers of clay underlying the base area, where present, would locally restrict the hydraulic connection between the shallow and the deeper bedrock aquifer. Soil boring and well log data indicate that clay layers are not continuous across the base, or in some locations may be interbedded with permeable sands or gravel. Thus, a hydraulic connection may exist at some locations at the base which could allow potential surface contaminants to reach the bedrock aquifer.

Well records from the Wisconsin Geological and Natural History Survey indicate there are 56 wells within a 1-mile radius of the base. Of the 56 wells, 22 are either screened or are open holes at depths less than 100 feet BLS. Location information for water wells within a 1-mile radius is presented in Table 3.1 and Figure 3.7. Located just beyond the 1-mile radius are 136 additional water wells. WDNR reports that there are somewhere between 500 and 1,000 wells within a 4-mile radius of the base. There are no known public drinking water wells in the area. Although several wells are shown on Figure 3.7 as being located in the northwest portion of the base, no wells in that area are known to exist, and these locations are attributed to erroneous location information in the well construction reports.

The sole water source for facilities located at the western portion of the ANG base (at the former location of the 128th TCF unit) is a water well which was constructed in 1950 (see



SOURCE: USGS HYDROLOGICAL INVESTIGATIONS (ATLAS HA-432)

FIGURE 3.6

BILLYMIT\GW-FLOW

REGIONAL GROUNDWATER FLOW
128th ARW, Gen. Billy Mitchell Field ANGB
Milwaukee, Wisconsin

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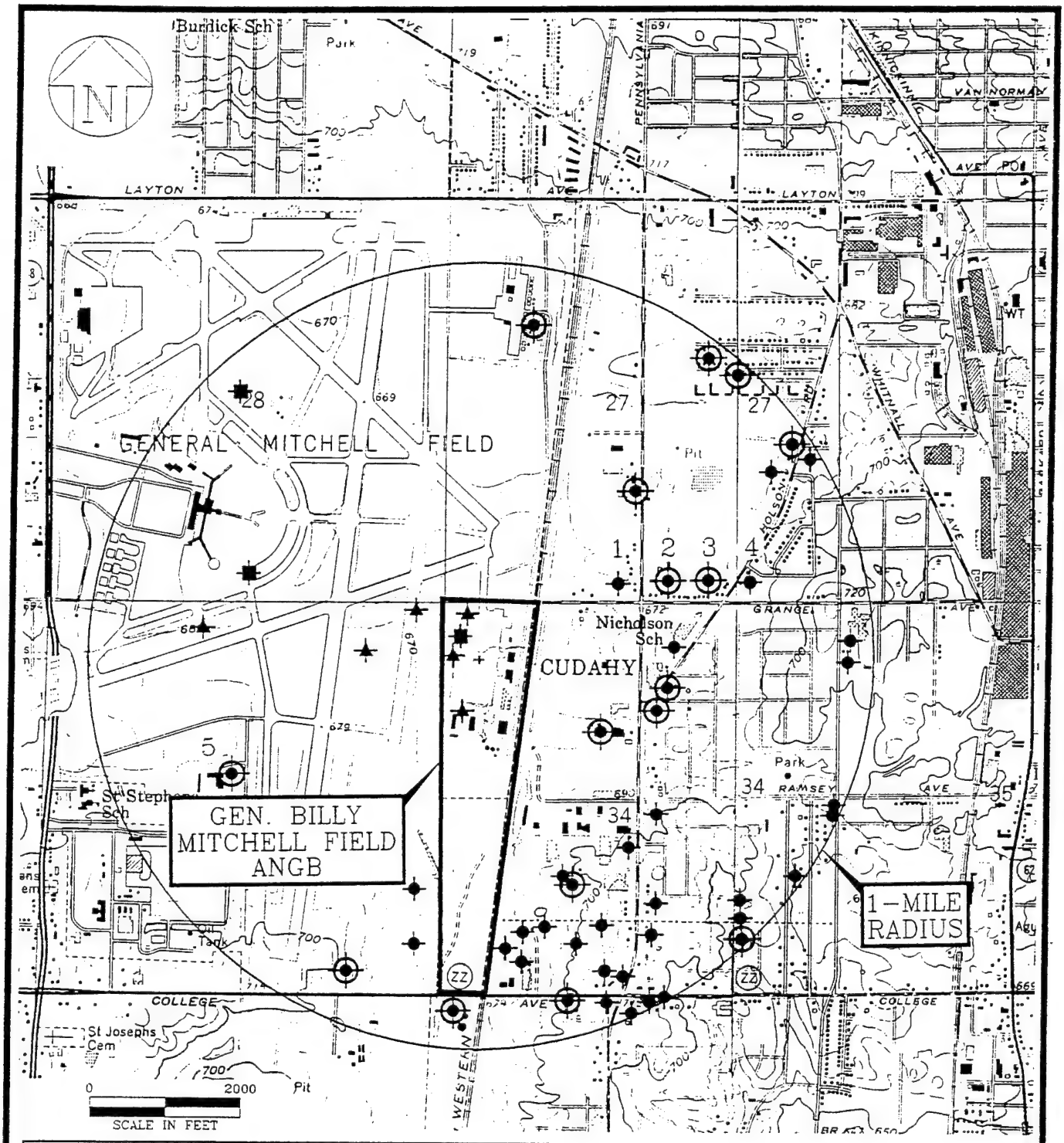

LEGEND

- WELL WITHIN 1 MILE RADIUS
- WELL WITHIN AN OPEN INTERVAL ABOVE 100' BLS
- *WELLS 1, 2, 3, 4, 5 HAVE ADDITIONAL INFORMATION IN TABLE 3.1.
- WELL WHICH MAY BE ABANDONED DUE TO AIRPORT CONSTRUCTION AND EXPANSION
- WELL WITH AN OPEN INTERVAL ABOVE 100' BLS AND WHICH MAY BE ABANDONED DUE TO AIRPORT CONSTRUCTION AND EXPANSION

DRAFT
FIGURE 3.7
BILLY\WELLS

LOCATION OF WATER WELLS IN THE VICINITY OF GEN. BILLY MITCHELL FIELD ANGB
128th ARW, Gen. Billy Mitchell Field ANGB
Milwaukee, Wisconsin

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MARCH 1996

Table 3.1
Water Wells in 1-Mile Radius
128th ARW, General Billy Mitchell Field ANGB, Milwaukee, Wisconsin

Location				Open Hole Interval (ft BLS)
Township	Range	Section	Quartiles	
6N	22E	33	NE, NE	10 - 49*
6N	22W	34	–	24 - 50
6N	22E	34	–	109 - 156
5N	22E	3	W½	94 - 121
5N	22E	3	N½	125 - 173
5N	22E	3	N½	113 - 141
5N	22E	3	N½	96 - 296
5N	22E	3	N½	125 - 202
5N	22E	3	E½, NW	142 - 172
5N	22E	3	NE, NE, NW	101 - 158
5N	22E	3	NE	107 - 150
6N	22E	27	SW¼	94 - 150
6N	22E	27	SW, SW, SE	110 - 133**
6N	22E	27	SW, SW, SE	87 - 175**
6N	22E	27	SE, SW, SE	111 - 179**
6N	22E	27	SE, SW, SE	100 - 171**
6N	22E	27	SW, NW, SE	120 - 154
6N	22E	27	NE, SE	99 - 185
6N	22E	27	NE, SE	99 - 137
6N	22E	27	SE, NE, SE	104 - 115
6N	22E	27	W½, NW	89 - 131
6N	22E	27	S½, NE	19 - 50
6N	22E	27	SW, SE, NE	74 - 107
6N	22E	33***	SE, NW	85 - 300**
6N	22E	33	SE, NE, SW	98 - 127
6N	22E	33	NE, NW	95 - 140
6N	22E	33	NE, NE	84 - 150
6N	22E	33 - 34	–	82 - ±140

Table 3.1 (Continued)
Water Wells in 1-Mile Radius
128th ARW, General Billy Mitchell Field ANGB, Milwaukee, Wisconsin

Location				Open Hole Interval (ft BLS)
Township	Range	Section	Quartiles	
6N	22E	34	–	109 - 156
6N	22E	34	SE, NW, NW	81 - 101
6N	22E	34	–	115 - 145
6N	22E	34	E½	107 - 137
6N	22E	34	SW¼ of SW¼	105 - 145
6N	22E	34	SE, SE, SW	133 - 175
6N	22E	34	SE, SE, SW	128 - 170
6N	22E	34	SE, SE, SW	123 - 190
6N	22E	34	S½, SE	94 - 158
6N	22E	34	S¼, SE	110 - 177
6N	22E	34	SW, SE	120 - 150
6N	22E	34	SW, NW, SE	117 - 161
6N	22E	34	SW, NW, SE	119 - 160
6N	22E	34	NE, SE, SW	120 - 175
6N	22E	34	NW, NE, SE	108 - 128
6N	22E	34	NE, NE, SE	118 - 155
6N	22E	34	SE, NW	102 - 130
6N	22E	34	NE, SE, NW	90 - 189
6N	22E	34	NW, NW, NW	114 - 145
6N	22E	34	NE, NW	92 - 135
6N	22E	34	W½, NE	97 - 194
6N	22E	34	SW, NW, NE	93 - 130
6N	22E	35	NW, NW¼, SW¼	113 - 136
6N	22E	35	SW, NW, NW	0 - 132*
6N	22E	35	SW, NW, NW	150 - 204
5N	22E	33	NE, SE, SE	157 - 197
5N	22E	33	NE, SE, SE	155 - 158

Table 3.1 (Concluded)
Water Wells in 1-Mile Radius
128th ARW, General Billy Mitchell Field ANGB, Milwaukee, Wisconsin

Location				Open Hole Interval (ft BLS)
Township	Range	Section	Quartiles	
5N	22E	34	NW, NW, SW	138 - 201

ft BLS – feet Below Land Surface.
* – Pipe was set in interval indicated. There was no notation of open hole or screened interval.
** – The five wells located nearest the base.
*** – The section was erroneously reported as Section 28 on the well log.
N – North.
S – South.
E – East.
W – West.
NE – Northeast.
NW – Northwest.
SE – Southeast.
SW – Southwest.

well number 5 on Figure 3.7). The open hole well was completed to a total depth of 300 feet BLS and is cased to 105 feet below the surface. The well pumps from dolomite bedrock (the Niagara Aquifer). Although these facilities are not utilized as frequently as when the 128th TCF unit occupied the area, they are occasionally used for classroom training, and the well is periodically tested for bacteria levels by the local Health Department (Huelsman, 1995). According to the Phase I Addendum Records Search conducted in 1986, low levels of chlorinated organic compounds were detected in the 128th TCF well in 1985, and additional sampling and analysis for petroleum hydrocarbons and aromatic and halogenated volatile organics was recommended. The well is located downgradient from a former Air Force Reserve fire-training area and hazardous waste storage area, and numerous industries are also located in the surrounding area (HMTC, 1986).

Located less than one-quarter mile east of the base is the Mama Bear Day Care Center. According to the well driller's report to the Wisconsin State Board of Health (dated December 29, 1945), an open hole well at the property was drilled to a depth of 133 feet BLS and encountered water-bearing strata at 110 feet BLS. Due to the absence of a municipal water main along Grange Avenue, the day care center and several residences rely on domestic wells for water (Huelsman, 1994). These wells are identified as numbers 1, 2, 3, and 4 in Figure 3.7. According to drillers' logs, the wells on East Grange Avenue are screened into the Niagara Aquifer, and the screen does not extend into the overlying gravel. In these wells the sand and gravel aquifer is separated from the limestone by approximately 10 feet of sandy clay.

Water samples were collected from four residences on East Grange Avenue, including the Mama Bear Day Care Center, on December 21, 1995. The water samples were analyzed for VOCs,

DRO, GRO, PAH, and lead. No analytes were detected above quantitation limits; the analytical data are included in Appendix I.

3.5 SURFACE WATER

Lake Michigan is located approximately 2.5 miles east of the base. Lake Michigan is the primary source of drinking water for the Milwaukee area and supplies the municipal water system.

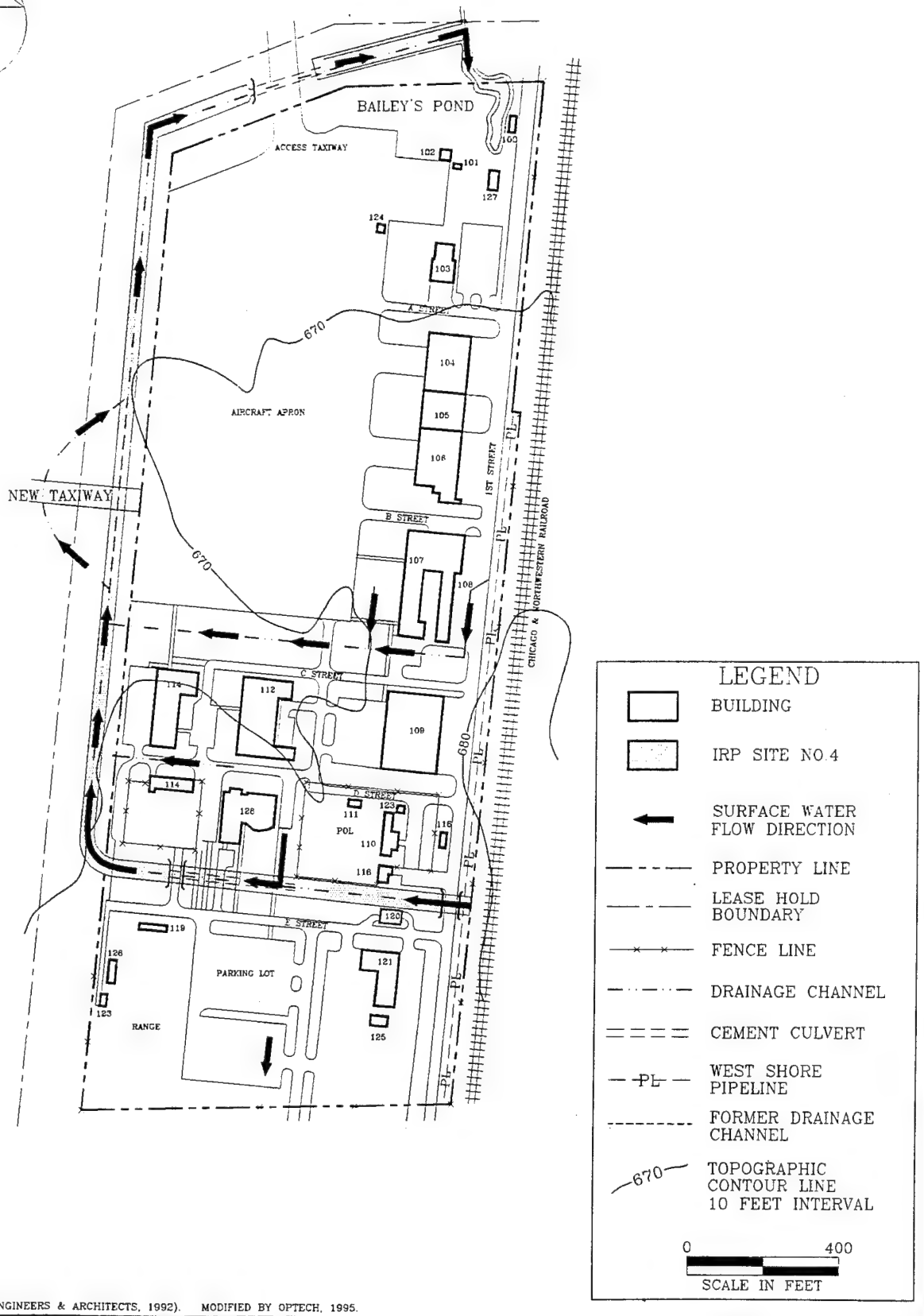
The Milwaukee and the Menomonee rivers are located approximately 5 miles north of the base. Root River is located approximately 8.5 miles west of the base. The nearest creek, Oak Creek, is located approximately 0.5 miles west of the base.

3.5.1 Current Drainage

Surface water drainage at the base is largely controlled by the base drainage ditch (IRP Site No. 4). The direction of surface drainage is shown in Figure 3.8. Surface water runoff, north of the base drainage ditch, flows west into the base drainage ditch. Near the western boundary of the base, surface water within the base drainage ditch flows north to Bailey's Pond. Surface water in Bailey's Pond is ultimately discharged into a city storm sewer inlet. Bailey's Pond, considered a wetland area, is a shallow, marshy pond unsuitable for any recreational use. However, the pond can be considered a receptor for any contamination migrating within the drainage ditch. South of the base drainage ditch, surface water runoff flows to the south and west into Oak Creek (Figure 3.9).

3.5.2 Historical Drainage

Surface drainage during the late 1960s and early 1970s was similar to the current surface drainage shown on Figure 3.8. An aerial photograph, taken by Park Aerial Services, Inc., in April 1970, is shown in Figure 3.10. An additional drainage ditch existed south/southeast of Building 112 in the area currently occupied by Building 128. Surface water flowed south and discharged into the base drainage ditch.



SOURCE: (DONOHUE ENGINEERS & ARCHITECTS, 1992). MODIFIED BY OPTECH, 1995.

FIGURE 3.8

BILLYMIT\BASESURF

BASE SURFACE DRAINAGE

128th ARW, Gen. Billy Mitchell Field ANGB
Milwaukee, Wisconsin

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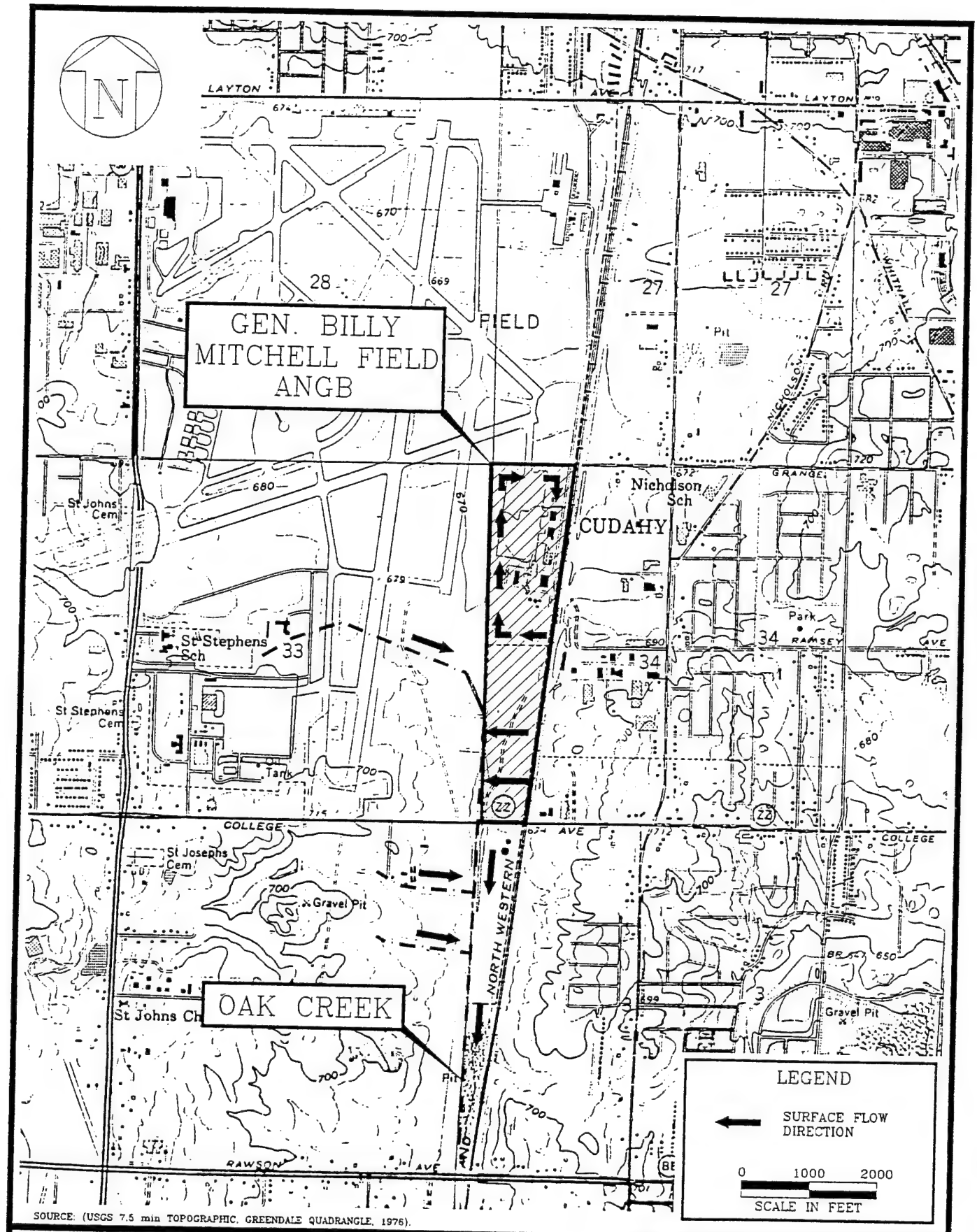
MARCH 1996



SOURCE: (USGS 7.5 min TOPOGRAPHIC, GREENDALE QUADRANGLE, 1976).

FIGURE 3.9

BILLYMIT\75TOPO

SURFACE FLOW DRAINAGE MAP

128th ARW, Gen. Billy Mitchell Field ANGB
Milwaukee, Wisconsin

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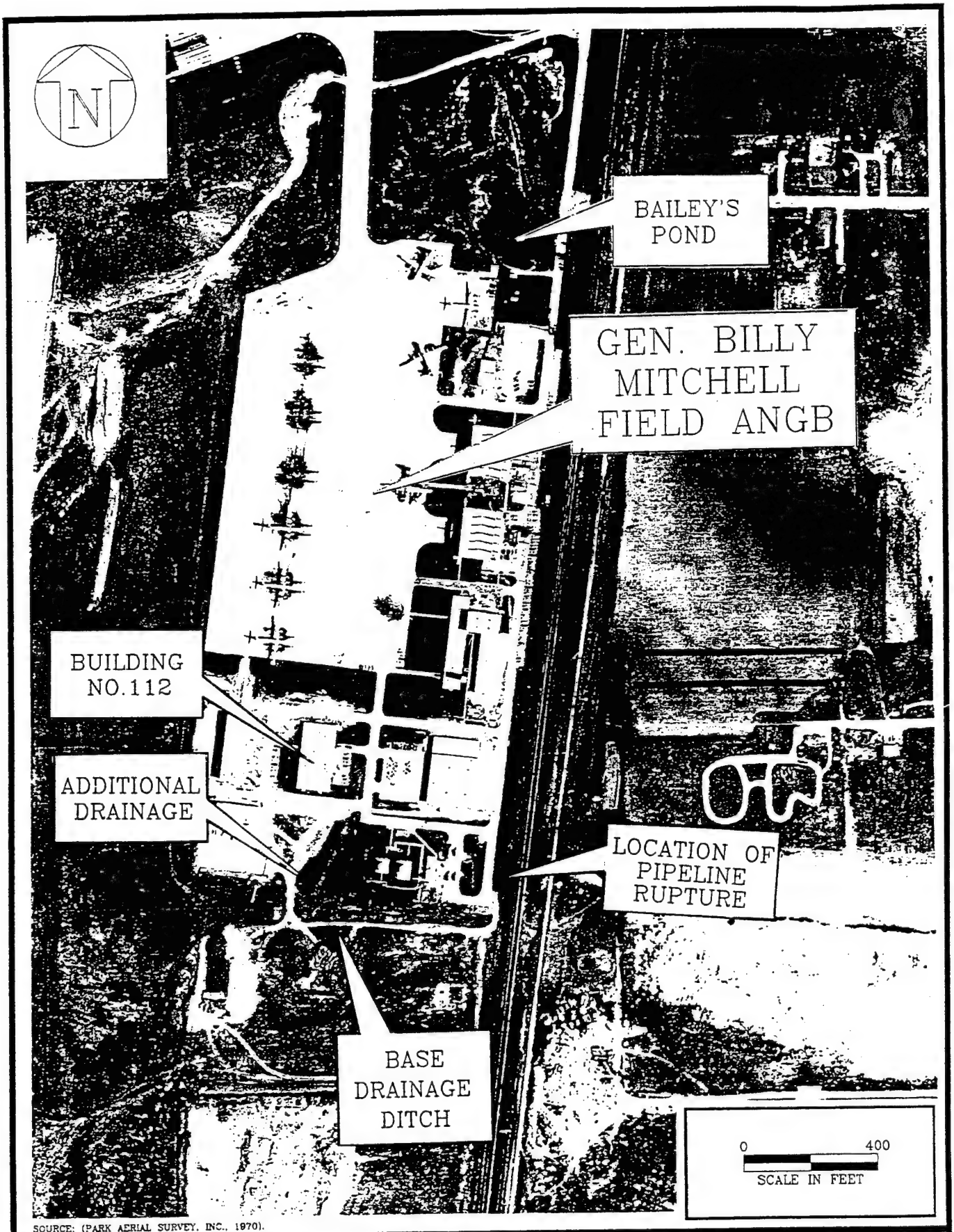
MARCH 1996



SOURCE: (PARK AERIAL SURVEY, INC., 1970).

FIGURE 3.10

BILLYMIT\AIRPHOTO

1970 AERIAL PHOTO

128th ARW, Gen. Billy Mitchell Field ANGB

Milwaukee, Wisconsin

OPTECH
OPERATIONAL TECHNOLOGIES CORPORATION

MARCH 1996

3.6 CRITICAL HABITATS/ENDANGERED OR THREATENED SPECIES/WETLANDS

The surface water drainage ditch near the north edge of the base is overgrown with cattails. Cattails are considered hydrophytic vegetation, a indicator species of wetlands. Therefore, this area falls within the definition of a wetland according to the Wisconsin Wetland Inventory Classification Guide. There are 35 wetlands smaller than 2 to 5 acres, five man-made ponds, and 19 general hydrologic cover type wetlands located within a 1.5-mile radius of the base.

The Army Corps of Engineers (COE) was contacted regarding the status of the base as a wetland, and the COE reported that the base does require a Section 404 permit (Kolb, 1994).

An environmental area of significance, the Michael F. Cudahy Nature Preserve, is located approximately over a mile southwest of the base. The 60-acre site is an upland hardwood forest, with a rich herbaceous layer. Two major forest types are found on the property, and habitat for a State endangered species, *Solidgo caesia* (blue-stemmed golden rod) is also found on the site (WESTON, 1984).

According to Ms. Janet Smith, Field Supervisor with the U. S. Fish and Wildlife Service, the Federally listed endangered peregrine falcon, *Falco peregrinus*, may be found in Milwaukee County. However, activities at the base are not expected to have a negative impact on the species (U. S. Fish and Wildlife, 1995).

SECTION 4.0 FIELD PROGRAM

The purpose of this SI was to confirm, through field activities, the presence or absence of contamination at IRP Site No. 4, to attempt to determine the areal extent of any contaminants detected, and to provide data needed to reach a decision point for addressing environmental concerns at the site. In addition, information was obtained during field activities and report preparation to complete the Hazard Ranking System (HRS) "Data Requirements for Federal Facilities Docket Sites." This section describes the field activities performed during the SI to accomplish the above objectives, and the methodologies used to conduct these activities.

Field activities for the SI, including one round of groundwater sampling, were performed from 18 October 1994 through 10 November 1994. A second round of groundwater sampling was conducted on 20 December 1994.

4.1 GENERAL INVESTIGATIVE APPROACH

The field investigation at the base included the installation of push-sample soil borings/piezometers and groundwater monitoring wells in order to:

- Screen soil and groundwater for contamination;
- Determine base-wide groundwater flow direction;
- Collect soil data at the IRP site;
- Collect groundwater data at the IRP site; and
- Evaluate the magnitude and extent of any contaminant impacts to soil or groundwater.

The investigative approach was divided into two phases: (1) screening activities designed to gather preliminary data in order to guide the selection of monitoring well locations or to determine groundwater flow direction prior to the installation of monitoring wells; and (2) confirmation activities designed to verify the presence or absence of soil and groundwater contamination, the distribution and magnitude of contaminants detected, and to define geologic and hydrogeologic characteristics at the site.

A total of 38 push-sample borings and four push-piezometers were installed to obtain surficial groundwater samples (from depths no greater than 12 feet BLS) for screening purposes, and to acquire soil samples for confirmation purposes. Five monitoring wells were then installed to collect confirmation groundwater samples and evaluate groundwater flow direction at the site.

Rising head slug tests were performed in four of the monitoring wells to estimate the hydraulic conductivity of the shallow aquifer. Table 4.1 summarizes the activities performed during the SI.

Table 4.1
IRP Site No. 4 Site Investigation Summary
128th ARW, General Billy Mitchell Field ANGB, Milwaukee, Wisconsin

Activities		Number and Type of Sample Locations	Number of Samples
Screening	Groundwater Sampling	8 Push-Samples	8
		4 Piezometers	4
Confirmation	Soil Sampling	38 Push-Samples	74
		4 Piezometers	9
	Groundwater Sampling	5 Monitoring Wells	10
	Slug Testing	4 Monitoring Wells	N/A

4.2 DEVIATIONS FROM THE WORK PLAN

There were eleven deviations from the Work Plan. However, none of the changed procedures or protocols prevented accomplishing the overall objectives of this SI. The deviations from the Work Plan and the rationale for the changes are described as follows:

- The number of required field blank Quality Assurance/Quality Control (QA/QC) samples was reduced from 16 to 5. The ANG Project Manager approved the change on the basis that an additional set of field blank QA/QC samples, as specified in the Work Plan, would not be required since no break in field activities of more than 48 hours occurred.

- Due to insufficient groundwater recharge at push-sample probe locations, groundwater sample field duplicates could not be collected at the rate specified in the Work Plan. The ANG Project Manager was notified of this condition.

- Due to insufficient groundwater recharge at push-sample locations, collection of groundwater samples for laboratory analysis was stopped. The ANG Project Manager approved the cessation of groundwater sampling on 26 October 1994.

Groundwater samples continued to be collected from these locations for field screening by gas chromatograph (GC) analysis.

- Groundwater samples for field GC analysis could not be collected at some push-sample points due to bore hole collapse. The ANG Project Manager was notified.

- The complete analytical suite for groundwater samples collected from push-piezometer 004-003PZ could not be performed because an adequate volume of groundwater could not be collected from the piezometer. Silt and clay were suspected of clogging the screened interval of the push-piezometer. The ANG Program Manager was notified of the problem.

- Due to insufficient sample volume recovery at several of the push-sample probe locations, the complete analytical parameters for some of the soil samples could not be performed.

- The heights of the monitoring well guard posts were reduced from 4 feet to 3 feet at the request of the base Civil Engineer. The deviation was approved by the ANG Project Manager.

- At the direction of the ANG Project Manager, a rising head slug test was not performed at monitoring well 04-003MW due to high contaminant concentrations detected in groundwater samples collected from the well.

- Several push-sample probe locations were moved to avoid obstacles. These location changes were approved by the ANG Project Manager.

- Holding times were exceeded by the laboratory for eight soil samples which were to be analyzed for DRO. Corrective action was initiated and re-sampling and analysis was completed.

- Holding times were exceeded by the laboratory for VOC analysis for two groundwater samples in the second round of sampling.

4.3 FIELD SCREENING ACTIVITIES

4.3.1 Push-Sample Piezometer Installation

Four push-installed piezometers were installed to initially estimate groundwater flow direction for the purpose of locating monitoring wells, and to collect soil and groundwater samples for laboratory analyses.

The piezometers were installed using a Strataprobe™ push-sampler, a lightweight hydraulic drive point system. The Strataprobe™ sampling unit was operated by TEG/Target of Columbia, Maryland. The Strataprobe™ direct-push technology consisted of a hydraulic and percussion drive-point system on a truck-mounted unit. A 2-inch-diameter drive rod was pushed into the ground using a dual-ram hydraulic configuration and the weight of the vehicle on which the system was mounted. The Strataprobe™ obtained discrete soil samples using a retractable piston sampler. The sampler consisted of a standard split-spoon with a piston assembly added to control the sampling depth. Upon reaching the desired depth, the piston was unlocked and the sampler advanced to collect the soil sample. Samples were collected into brass sleeves.

Strataprobe™ rods, the Strataprobe™ rig, and all sampling tools were steam-cleaned in a designated decontamination area located north of Building 101 before initial use and after the completion of each piezometer. Piezometer casing and screen remained in the factory packaging until immediately prior to installation, to insure against contamination before insertion into the ground.

The push-piezometers were installed by advancing the Strataprobe™ approximately 5 to 6 feet below the depth at which groundwater was first noted while collecting soil samples. The Strataprobe™ was then withdrawn and the piezometer casing and screen hand-installed into the penetration. The rig's hydraulic system was used as necessary to assist in advancing the piezometer to the proper depth.

All push-piezometers were constructed of Schedule 40, 3/4-inch inside diameter (ID) polyvinyl chloride (PVC) casing and screen. The screened interval of each piezometer consisted of a 5-foot section of 0.010-inch slotted screen fitted with a PVC terminal cap. All push-piezometers were installed to a depth of 16 feet BLS. The tops of the screened intervals were positioned approximately one foot below the depth at which groundwater was first encountered in the penetrations. All push-piezometer coordinates, top-of-casing, and surface elevations were determined by the contracted surveyor. The surveyor's report is included in Appendix A.

The static water level in each push-piezometer was allowed to equalize a minimum of 24 hours before measurement using a Solinst™ water level indicator. A second water level measurement was taken prior to purging and sampling the piezometers.

Groundwater samples were collected for screening purposes from all piezometers with the exception of push-piezometer 04-003PZ. Each push-piezometer was purged using a Teflon™ bailer immediately prior to sample collection. Purging was considered complete when a minimum of three casing volumes had been removed and the purged groundwater was free of sand. Groundwater samples were collected using a decontaminated Teflon™ bailer and placed in a 40-milliliter (mL) vial fitted with a Teflon™-lined septum lid, and processed for field GC screening. Monofilament line, used to lower groundwater sampling equipment into the piezometers, was replaced after sampling each location. Additionally, groundwater samples were collected and submitted for laboratory analyses by methods described in Subsection 4.4.4.2.

After sampling and groundwater measurement activities were completed, all piezometers were removed and the penetrations grouted to surface with pure bentonite grout in accordance with Wisconsin State requirements.

4.3.1.1 Soil Screening

During installation of the push-piezometers, soil samples were collected at 5-foot intervals from surface to total depth for geologic classification, photoionization detector (PID) and field GC screening, and laboratory analyses. A minimum of one soil sample from a depth of one foot BLS and one sample from immediately above the water table were collected and submitted for laboratory analysis from each push-piezometer location by methods described in Subsection 4.4.4.1. However, due to the nature of the soil (tight clay), it was virtually impossible to determine the water table level in all instances. Samples collected at depths less than 10 feet generally were not wet.

During soil sampling, a Micro Tip™ PID was used immediately upon opening the sampler to maximize the detection of volatiles from the soil samples. PID readings are indicated on the boring logs included in Appendix D. Once the soil sample was prepared for laboratory analysis, the remaining soil was field screened by ambient temperature headspace analysis (ATHA). The soil was placed in a sealable plastic bag, allowed to warm to ambient temperature, and the PID was used to conduct the ATHA to screen for photoionizable volatile compounds.

A Photovac 10SPlus™ Portable GC, calibrated to screen for benzene, toluene, ethylbenzene, and total xylenes (BTEX), was used to detect the presence of these compounds in the headspace from the soil samples collected. Headspace analysis was used to provide initial field information to characterize volatile compounds in the soil samples and to supplement data obtained from laboratory analysis. Field GC screening results with chromatograms are included in Appendix B.

4.3.1.2 Groundwater Screening

An attempt was made to collect grab samples of groundwater for screening activities from push-sample locations. Due to insufficient groundwater recharge into the push-sample locations and formation collapse, grab samples of groundwater were collected from only eight push-sample locations. Groundwater samples to be analyzed for VOCs were collected with a 40-mL Teflon™ bailer lowered through the Strataprobe™ rod or hand-installed PVC casing and screen. Groundwater samples to be analyzed for all other parameters were collected with a peristaltic pump fitted with new Teflon™ tubing lowered through the Strataprobe™ rod or PVC screen. Prior to collecting samples, all sampling equipment was decontaminated according to procedures described in the SI Work Plan.

The field GC was also used to analyze the headspace of groundwater samples collected from the push-piezometers in order to provide the Site Manager with preliminary water quality information, and to supplement data from water samples sent to the laboratory for analytical analysis. Field GC data is discussed in more detail in Section 5.0. Field GC screening results with chromatograms are included in Appendix B.

4.4 CONFIRMATION ACTIVITIES

OSI Environmental of Milwaukee, Wisconsin, was retained by OpTech as the monitoring well drilling contractor. TEG was retained for push-sampling and installation of piezometers. The contractors mobilized personnel and equipment that met or exceeded Wisconsin ANG and Wisconsin Department of Natural Resources (WDNR) requirements.

Pace Laboratories of Minneapolis, Minnesota, was retained to perform the laboratory analyses. Provisions were made by the laboratory for proper sample containers, labels, chain-of-custody forms, sample stabilization and preservation, and insulated coolers.

Nienow Engineering Associates of Milwaukee, Wisconsin, was retained as the surveying contractor. All push-sample locations, monitoring wells, piezometers, and base reference points were surveyed. Land surface elevations and other pertinent survey data for each location are shown on the well construction diagrams and boring logs included in Appendices C and D, respectively, as well as the surveyor's report included in Appendix A.

4.4.1 Push-Sample Locations

Soil samples were collected from push-sample borings for laboratory analysis, to define any existing soil contamination, and to aid in defining the vertical and horizontal extent of contaminants at each site. Soil samples were also used for determining site geology and subsurface soil characteristics. Push-sample soil penetrations were advanced using the Strataprobe™ system as previously described in Subsection 4.3.1 for push-piezometers.

A total of 38 push-sample locations were installed for data collection. All work was performed in a manner consistent with Wisconsin State regulations. The maximum depth of penetration was between 10 and 17 feet BLS with soil samples collected from immediately below the surface (from 1 to 3 feet BLS), at 5 feet BLS, and at 10 feet BLS for lithologic characterization, field screening, and laboratory analysis. Due to the "tight" clay soils, the water table level was not easily discernible; generally, samples collected from 10 feet were not wet. A 22-inch-long, carbon steel California-style sampler equipped with three 6-inch brass sleeves and one 4-inch brass sleeve was used for collecting soil samples. The California-style sampler was decontaminated and new brass sleeves inserted before each sampling event. Sample depths for each individual push-sample location are discussed in Section 5.0 and recorded on the borehole logs included in Appendix D. All soil samples collected were submitted for screening by PID and field GC, and selected samples were submitted for laboratory analyses.

Push-sample location abandonment activities conformed to applicable Wisconsin State requirements. Penetrations were backfilled to surface with pure bentonite grout immediately after the sampling had been accomplished to prevent the downward migration of contaminants through the open penetration. Push-sample location coordinates and ground elevation were determined by a professional surveyor.

4.4.2 Monitoring Well Installation

Five monitoring wells were installed to obtain water level data for hydrogeologic characterization of the shallow aquifer, evaluate horizontal groundwater flow directions, and to obtain

groundwater samples for laboratory analysis. The locations of monitoring wells were based on the detection of contaminated groundwater at the piezometer locations and the need to provide confirmatory information on groundwater flow direction at the base.

Monitoring wells were drilled using hollow-stem auger (HSA) drilling methods, which employs a hollow helical steel drill tool that is rotated to advance the boring and lift formation materials (cuttings) to the surface. The flights for the HSA are welded onto steel pipe and a cutter head is attached to the "lead" (bottom) auger to cut the hole. During drilling, a center bit is inserted into the hollow area of the cutter head that prevents cuttings from re-entering the hollow portion of the auger. Generally, the center bit is flush with or extends no more than 1/2 foot below the cutter head. The center bit connects through the auger flights by small diameter drill rods and is attached to the top-head drive unit of the drill rig. The top-head drive is powered by a truck-mounted engine that mechanically rotates the entire flight of augers. The hollow opening allows the insertion of sampling tools (i.e., split-spoon sampler) with the augers in place to prevent caving of the borehole.

Auger flights, drill rig(s), and tools were steam-cleaned in the designated decontamination area north of Building 101 before initial use and after the completion of each monitoring well. Likewise, all casing and screens installed in monitoring wells were unpackaged immediately prior to installation to insure to be free from any contamination before placement within the wellbore.

Monitoring wells were drilled at IRP Site No. 4 to total depths ranging between 18.98 feet BLS and 20.3 feet BLS. All monitoring wells were logged during drilling to evaluate site geology and subsurface soil characteristics. Soil samples were collected with split-spoon samplers from surface to total depth for field screening with the PID and the field GC. Monitoring wells were constructed in accordance with applicable Wisconsin State well standards.

Monitoring wells were constructed of 2-inch ID PVC casing and screen. The screened interval is a 10-foot section of 0.010-inch slotted screen with bottom cap. The top of the screen was placed approximately 2 feet above the depth at which groundwater was noted in the soil samples. A filter pack consisting of washed silica sand was placed around the screen to a point at least 2 feet above the top of the screen. A 2-foot (minimum) bentonite slurry seal was placed above each filter pack. Above the bentonite seal the annulus was filled to approximately one foot below grade with a pure bentonite grout.

All wells were completed by finishing the casing approximately 3 feet above the top of the borehole. A protective steel casing and 3-foot steel guard posts were installed in a concrete base to complete the well. An airtight well cap was provided with a stainless steel keyed-alike lock. The master key was given to the 128th ARW Environmental Coordinator. Monitoring well construction diagrams are included in Appendix C.

Monitoring well coordinates, top-of-casing and ground elevations were determined by a professional surveyor. Borings were surveyed to the nearest 1.0 foot horizontally and ± 0.01 foot vertically, and monitoring wells were surveyed to the nearest 1.0 foot horizontally and ± 0.01 foot vertically. The surveyor's report is included in Appendix A.

The static water level in each monitoring well was measured prior to development using a Solinst™ water level indicator. A second water level measurement was taken prior to purging and sampling the monitoring wells.

The monitoring wells were developed 24 hours after the last well was completed. Monitoring wells were developed using a Teflon™ bailer. Well development continued until three well volumes were removed and the groundwater was free of sand. After development, the wells were allowed to stabilize 24 hours prior to the first round of groundwater sampling.

Each monitoring well was purged immediately prior to sample collection. Wells were purged with a Teflon™ bailer. Purging was considered complete when field parameters of pH, temperature, and conductivity had stabilized and the volume of water in the screen, well casing, and saturated annulus had been removed from the well three times and the purged groundwater was free of sand.

Groundwater samples were collected using a decontaminated Teflon™ bailer and placed in appropriate containers with preservatives, if required, and sent to the laboratory for analysis. Additionally, groundwater samples were screened with the field GC to supplement data obtained from laboratory analyses. Dedicated decontaminated monofilament line was used to lower aqueous sampling equipment into the well.

4.4.3 Hydraulic Conductivity Measurements

A rising head slug test was conducted at each well, with the exception of 04-003MW, to determine the shallow aquifer hydraulic conductivity. A decontaminated slug, constructed of a 0.5-inch diameter, 32-inch long acrylic rod, was lowered below the water surface. The water

level in the wellbore was monitored using a Solinst™ Water Level Meter until it returned to the initial static level. The slug was removed after the pre-displacement water level had been reached, and the rise in water level back to its initial static level was measured at closely spaced time intervals using a Hermit™ Model SE1000C Environmental Data Logger. The resulting data was used to compute hydraulic conductivity, and is included in Appendix E.

4.4.4 Specific Media Sampling

The analytical program of the SI focused on the detection of contaminants typically associated with petroleum fuels and other petroleum substances. The parameters analyzed in soil and groundwater samples included VOCs, total petroleum hydrocarbons (TPH) measured as GRO and DRO, PAHs, and total lead. Laboratory analyses of soil and groundwater samples was performed in accordance with procedures that conform to the State of Wisconsin and United States Environmental Protection Agency (USEPA) guidelines published in the Methods for Chemical Analysis of Water and Wastes (USEPA 600/4-79-20), 1979, and Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846), 1986.

This subsection summarizes the analytical program followed for soil and groundwater samples collected during the SI. Also included in this subsection is a brief discussion of quality control procedures followed during the field sampling activities.

4.4.4.1 Soil Analyses

Soil samples were analyzed for VOCs by SW8020, PAHs by SW8310, DRO and GRO by the WDNR Modified Method, and total lead by SW6010. Table 4.2 summarizes the field sampling and analytical programs for the site.

4.4.4.2 Groundwater Analyses

Groundwater samples were also analyzed for VOCs by SW8020, PAHs by SW8310, lead by USEPA 239.2, TPH by DRO/WDNR Mod and GRO/WDNR Mod. In accordance with the Work Plan, groundwater samples collected for lead analysis were unfiltered. Two rounds of groundwater sampling and analysis were performed during the SI. Table 4.2 summarizes the field sampling and analytical programs for the site.

Table 4.2
Laboratory Analyses Summary Table
128th ARW, General Billy Mitchell Field ANGB, Milwaukee, Wisconsin

IRP Site No.	Matrix	Field Parameters	Lab Parameters & Test Methods	Investigative Samples	Number of Field QA/QC Samples					Matrix Totals*
					Trip Blanks	Equipment Blanks	Field Blanks	Field Duplicate	MS/ MSD	
4	Soil (Subsurface)	Field Screening using PID Field GC Soil Classification	VOCs/SW8020 PAHs/SW8310 Lead/SW6010 DRO/WDNR Mod. GRO/WDNR Mod.	83[a]	14**	6	4	3	1	97
	Groundwater	Field Screening using Field GC Temperature pH Specific Conductance	VOCs/SW8020 PAHs/SW8310 Lead/USEPA 239.2 DRO/WDNR Mod. GRO/WDNR Mod.	22[b,c]	5**	5	1	2	0	30

QA/QC – Quality Control/Quality Assurance.
MS/MSD – Matrix Spike/Matrix Spike Duplicate.
VOCs – Volatile Organic Compounds.
PAHs – Polynuclear Aromatic Hydrocarbons.
DRO – Diesel Range Organics.
GRO – Gasoline Range Organics.
WDNR – Wisconsin Department of Natural Resources.
* – Trip Blanks are not counted in Matrix Totals.
** – Trip Blanks are analyzed for VOCs only.
[a]Includes soil samples from piezometers.
[b]Includes groundwater samples from push-sample locations.
[c]Represents two rounds of groundwater sampling conducted two to four weeks apart.

4.4.4.3 Quality Control of Field Sampling

Field duplicate samples, field blanks, rinsate (equipment) blanks, and trip blanks were submitted to the analytical laboratory for assessment of the quality of data resulting from the field sampling program. Field and trip blank samples were analyzed to check for procedural contamination and ambient conditions at the site that may have caused sample contamination. Duplicate samples were submitted to provide a quality assurance check on analytical procedures and results.

Rinsate blanks were submitted to insure proper decontamination of equipment used to collect soil and water samples.

The level of the quality control effort included one field blank and one field duplicate, for approximately every 20 or fewer investigative soil samples and one equipment blank for approximately every 10 or fewer water samples. One VOC analysis trip blank, consisting of distilled, de-ionized, ultra pure water, was included along with each shipment of soil and water samples submitted for VOC analyses.

The quality control level of effort for the field measurement of groundwater pH consisted of a pre-measurement calibration and a post-measurement verification using two standard reference solutions each time. This procedure was performed at least once per day or more often as necessary. Quality control effort for field groundwater conductivity measurements included a daily calibration of the instrument using standard solutions of known conductivity.

4.4.4.4 Soil Sample Preservation

Soil samples submitted for laboratory analysis collected with a California-style sampler were contained in brass sleeves. Immediately upon removal from the California-style sampler, the sleeve ends were covered with a Teflon™ barrier, aluminum foil, and fitted with a plastic cap. Prepared samples were placed in sealed zip-lock plastic bags, immediately placed in the ice chest, and chilled to 4° Celsius (C).

4.4.4.5 Groundwater Sample Preservation

VOC samples were preserved with a 1:1 solution of hydrochloric acid to achieve a pH of less than 2 and were stored in 40-mL glass volatile organic analysis (VOA) vials with Teflon™-lined lids. Total recoverable lead samples were stored in 1/2-liter high-density polyethylene bottles with Teflon™-lined lids, and preserved with a solution of 1:1 nitric acid to achieve a pH of less

than 2. TPH samples were stored in 1-liter amber glass bottles with Teflon™-lined lids, and no preservatives were used.

4.5 EQUIPMENT CALIBRATION

4.5.1 Field GC

The field GC was calibrated at the beginning of each day using a three-point calibration method which included BTEX headspace standards of 100 parts per billion (ppb), 1 ppm, and 10 ppm. This headspace standard was prepared daily by dilution of a 2,000 ppm BTEX stock solution. The calibration was checked throughout the day, after completion of approximately 10 sample analyses. Air blank samples were also used to assess any problems with sample or calibration standard cross-contamination.

4.5.2 Photoionization Detector

Calibration of the PID was performed at the start of each day using a 100 ppm isobutylene gas standard. Additional calibrations were made during the day if unit readings became erratic, or if the unit was powered off. Calibration procedures were performed as outlined in the manufacturer's instructions.

4.6 INVESTIGATION DERIVED WASTE

During the SI, a certain amount of waste material (personal protective equipment (PPE), drill cuttings and purge water) was produced as a result of investigative activities. Drill cuttings were produced during the installation of monitoring wells. Drill cuttings were preliminarily characterized by monitoring for photoionizable compounds with a PID and screening with the Field GC. All soil cuttings produced during the investigation were contained in steel, Department of Transportation (DOT) certified, 55-gallon drums at the time of drilling. Additionally, development and purge water from each well location was drummed separately.

Miscellaneous derived wastes (e.g., gloves, plastic sheeting, and wipes) which came in contact with drill cuttings having PID readings less than 100 ppm, when field screened as described in Subsection 4.3.3, were disposed in a general refuse container in accordance with the Work Plan. All drums were properly marked to indicate their contents, the collection date, contractor's name and phone number, and borehole/monitoring well identification number.

The 128th ARW Environmental Coordinator reported that Waste Management, Inc. (WMI), a private waste contractor, is managing the transport and disposal of all drummed soil and groundwater investigative waste. Based on the results of soil and groundwater analyses, the waste was determined by the ANG to meet WDNR criteria for special non-hazardous wastes. WMI is treating the soil and groundwater at an off-site bioremediation cell and will dispose of the treated waste at an appropriate landfill.

SECTION 5.0 INVESTIGATIVE FINDINGS

5.1 BACKGROUND

In accordance with the HQ ANG/CEVR-approved Work Plan, background sampling was not conducted at General Billy Mitchell Field ANGB.

5.2 IRP SITE NO. 4 FINDINGS

5.2.1 Screening Activities

5.2.1.1 Push-Sample Piezometers Screening Results

Four push-sample piezometers were initially installed to determine groundwater flow direction and to collect soil and groundwater samples for laboratory analyses. Information obtained from push-sample piezometers was used to determine the need to implement optional groundwater monitoring well activities. Push-sample piezometers were used to confirm the absence or presence of soil and groundwater contamination at the base.

5.2.1.2 Field GC Screening Results

One hundred and four soil samples were collected from 38 push-sample soil locations, four push-sample piezometers and five monitoring wells at the site. These soil samples were screened with the field GC. The field GC was calibrated to screen for BTEX. Table 5.1 summarizes the maximum concentrations detected in both soil and groundwater samples. Complete GC data is included in Appendix B.

5.2.1.2.1 Soil – Field GC Results

Benzene was detected in 38 soil samples, with a maximum concentration of 111,000 ppb detected in sample 04-014PS (7 - 9 feet BLS). Toluene was detected in 42 soil samples, with a maximum concentration of 214,000 ppb detected in sample 04-003PS (10 - 12 feet BLS). Ethylbenzene was detected in 27 soil samples, with a maximum concentration of 87,400 ppb detected in piezometer 04-028PZ (5 - 7 feet BLS). M,p-xylene was detected in 30 soil samples, with a maximum concentration of 539,000 ppb detected in sample 04-018PS (5 - 7 feet BLS). O-xylene was detected in 16 soil samples, with a maximum concentration of 123,000 ppb detected in sample 04-018PS (5 - 7 feet BLS).

Table 5.1
Maximum GC Concentrations Detected
in Soil and Groundwater Samples Collected at IRP Site No. 4
128th ARW, General Billy Mitchell Field ANGB, Milwaukee, Wisconsin

Compound	Maximum Concentrations Detected in Soil Samples (ppb)	WDNR Soil Cleanup Guidelines (μg/kg)	Maximum Concentrations Detected in Groundwater Samples (ppb)	WDNR Groundwater Protection Standard (μg/L)
Benzene	111,000	5.5	178,000	5
Toluene	214,000	1,500	52,500	343
Ethylbenzene	87,400	2,900	14,900	700
M,p-xylene	539,000		290,000	
O-xylene	123,000	4,100*	65,300	620*

* – Total xylenes.
GC – Gas Chromatograph.
ppb – Parts per billion.
μg/kg – Micrograms per kilogram.
μg/L – Micrograms per liter.

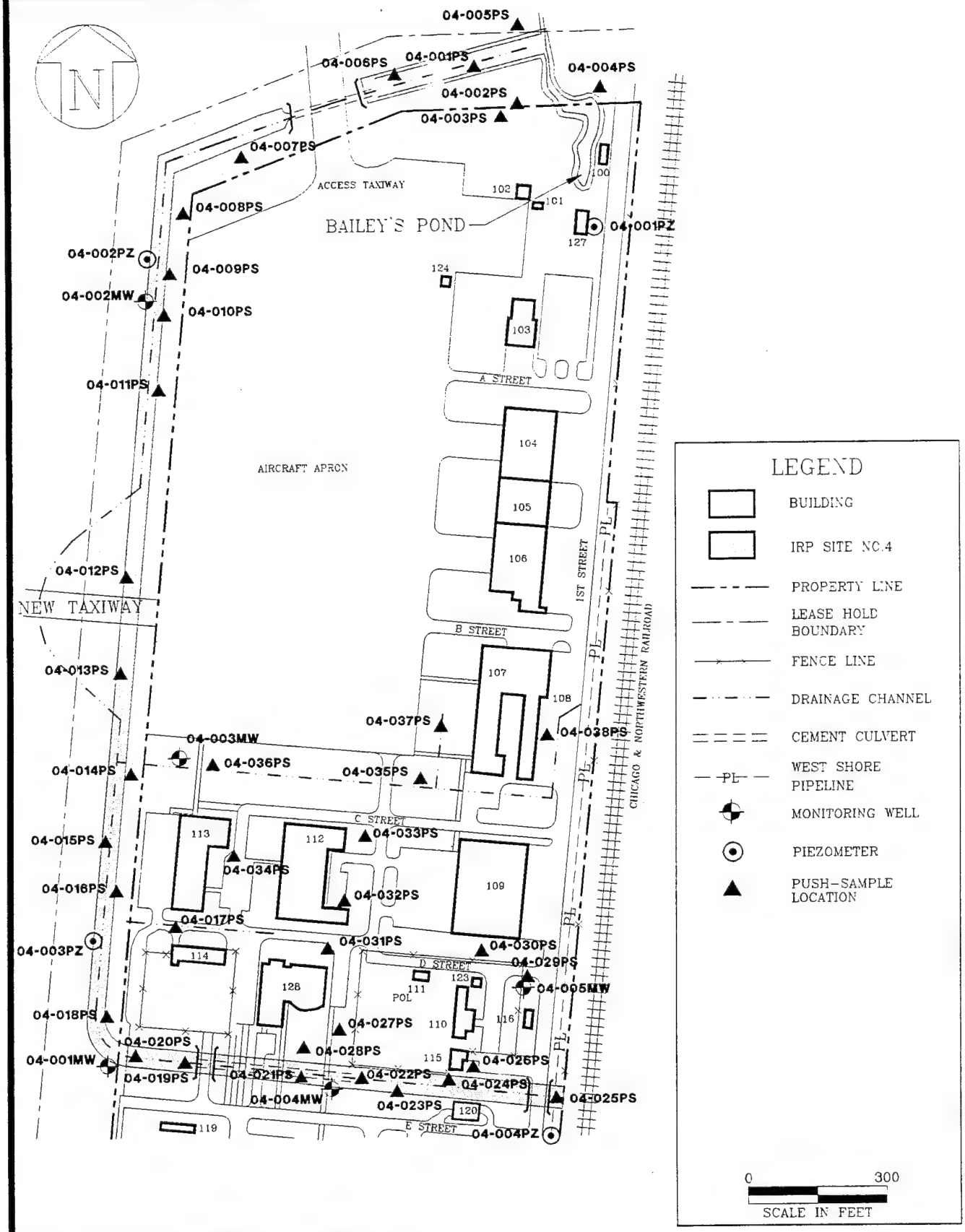
5.2.1.2.2 Groundwater – Field GC Results

Of the 41 groundwater samples screened with the field GC, benzene was detected in 20 of the samples, with a maximum concentration of 178,000 ppb (5X dilution) detected in groundwater samples from monitoring well 04-003MW. Toluene was detected in 28 groundwater samples, with a maximum concentration of 52,500 ppb (5X dilution) detected in groundwater samples from monitoring well 04-003MW. Ethylbenzene was detected in 14 groundwater samples, with a maximum concentration of 14,900 ppb detected in a groundwater sample from 04-028PS. M,p-xylene was detected in 14 groundwater samples, with a maximum concentration of 290,000 ppb (20X dilution) detected in a groundwater sample from 04-015PS. O-xylene was detected in six groundwater samples, with a maximum concentration of 65,300 ppb detected in a groundwater sample from piezometer 04-003PZ. Complete field GC data is included in Appendix B.

5.2.2 Soil Investigation Findings

5.2.2.1 Push-Sample Locations

Thirty-eight push-sample locations were used at the site to obtain soil samples for laboratory analysis, and to aid in defining the vertical and horizontal extent of contamination. Soil samples were also obtained during the installation of push-sample piezometers. Soil samples were used for characterizing site geology and subsurface soil conditions. The push-sample and piezometer locations for IRP Site No. 4 are indicated in Figure 5.1.



SOURCE: (DONOHUE ENGINEERS & ARCHITECTS, 1992). MODIFIED BY OPTECH, 1995.

FIGURE 5.1

BILLYMIT\BM-BORE2

PUSH-SAMPLE, PIEZOMETER AND MONITORING WELL LOCATIONS

128th ARW, Gen. Billy Mitchell Field ANGB
Milwaukee, Wisconsin

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5.2.2.2 Subsurface Geology

Soil samples collected from the push-sample borings, push-sample piezometers, and monitoring wells were used to provide geologic information for describing the subsurface geology at the site. Complete lithologic logs for the borings and wells drilled at IRP Site No. 4 are presented in Appendix D.

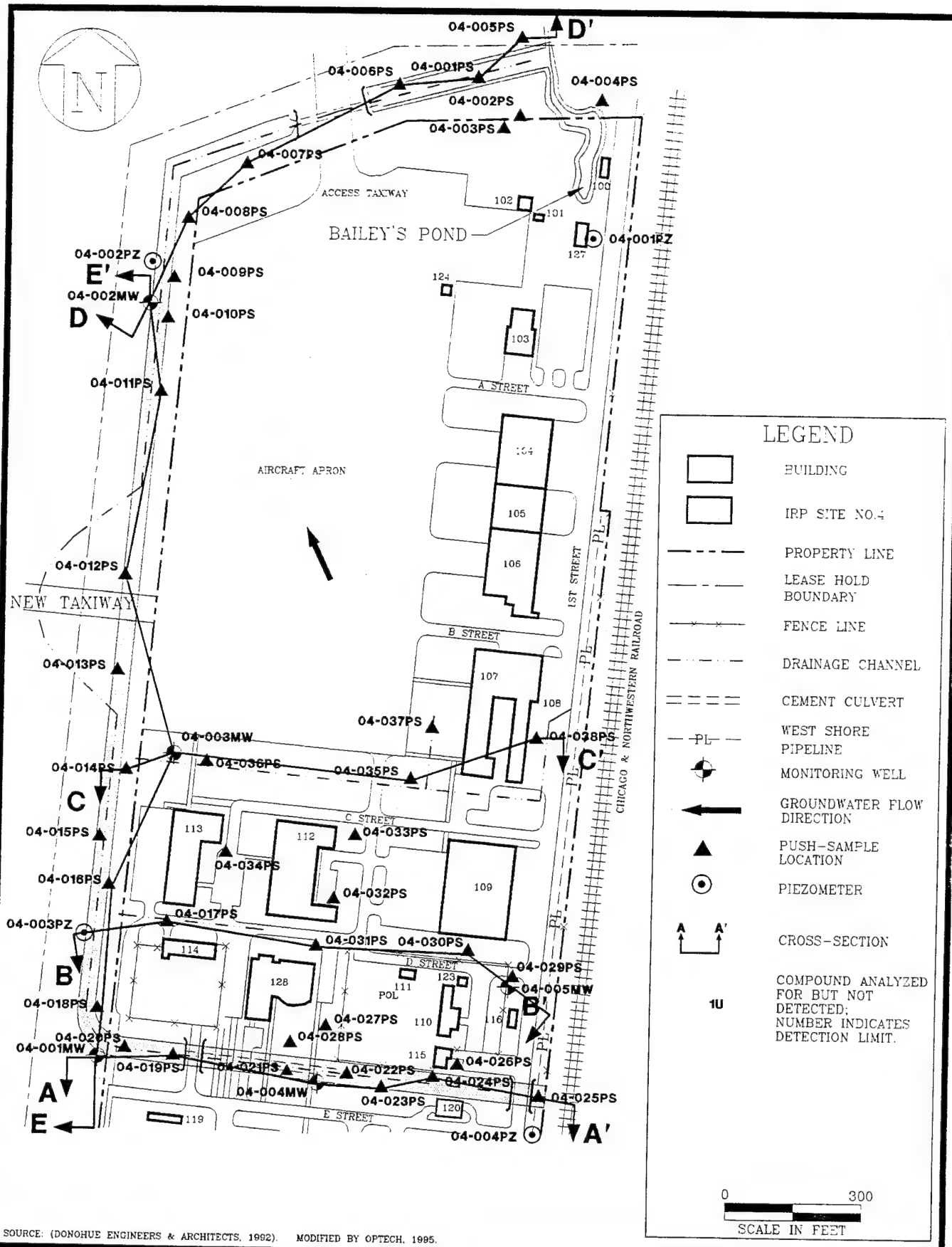
The subsurface at 128th ARW can be divided into two general lithologic units. The upper unit is predominately a clay facies comprised of clay, silty clay, and sandy clay. Thickness of the clay facies ranges from 5 to 12 feet. Clay and silty clay is generally dense and plastic. Color varies from black and dark gray at the surface, indicating organic content, to brown and olive color at the base. Abundant roots were noted at the surface. Moisture content of the clays varied from dry conditions at the surface to very moist or saturated conditions at the contact with the lower sand facies, indicating confined or semi-confined conditions.

The lower unit is predominately a sand facies comprised of sand, clayey sand, and gravelly sand. Sands are generally fine-grained to coarse-grained and poorly sorted, and are generally wet. Push-samples and monitoring wells were not driven or drilled to sufficient depth to determine thickness. Individual units within the facies exhibits a high degree of variability, both horizontally and vertically. This is typical of glacial deposits. Geologic cross-sections depicting the subsurface geology are indexed on Figure 5.2 and shown on Figures 5.3, 5.4, 5.5, 5.6, and 5.7.

5.2.2.3 Nature and Extent of Soil Contamination

Seventy-four investigative and two duplicate soil samples were collected for laboratory analysis from 38 push-sample locations at IRP Site No. 4. Most of the locations were pushed to a depth of 10 feet; however, some locations were pushed to 12 feet in an attempt to obtain soil samples in areas of poor recovery. Samples were collected from 20 October 1994 to 31 October 1994. Push-sample piezometers were advanced to a depth of 12 feet, and an additional nine investigative and one duplicate soil samples were collected from 28 October 1994 to 31 October 1994. Sampling intervals submitted for laboratory analysis and the analytical program are presented in Table 5.2. A complete listing of laboratory results for all analyses is given in Appendix G.

Holding times were exceeded for eight soil samples which were to be analyzed for DRO. The laboratory exceeded 14-day holding periods for samples collected from push-sample soil borings



SOURCE: (DONOHUE ENGINEERS & ARCHITECTS, 1992). MODIFIED BY OPTECH, 1995.

FIGURE 5.2

BILLYMIT\BM-BORE

GEOLOGIC CROSS-SECTIONS
LOCATION MAP

128th ARW, Gen. Billy Mitchell Field ANGB
Milwaukee, Wisconsin

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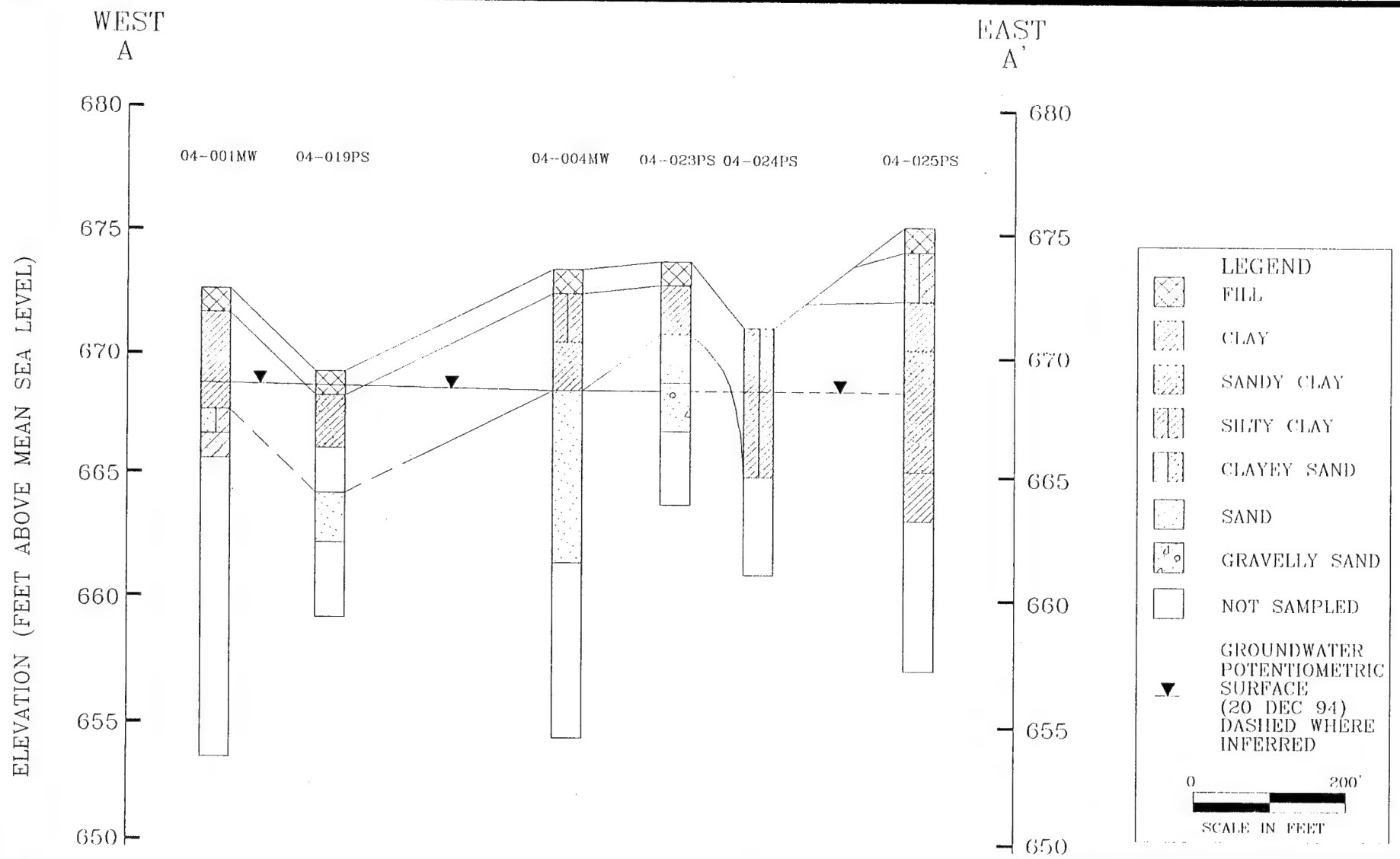

FIGURE 5.3

BILLYMIT\AA

GEOLOGIC CROSS-SECTION A-A'
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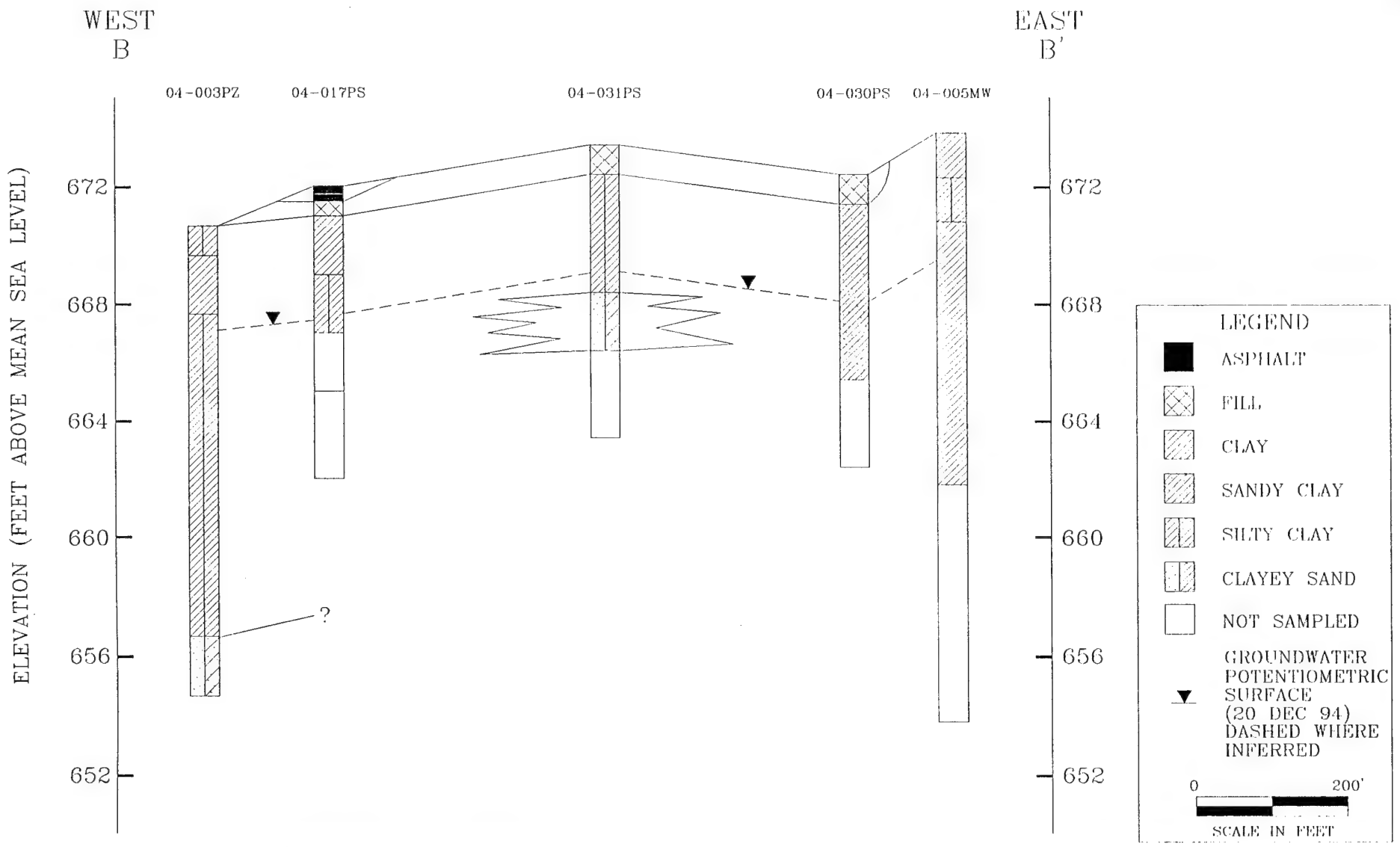

FIGURE 5.4

GEOLOGIC CROSS-SECTION B-B'

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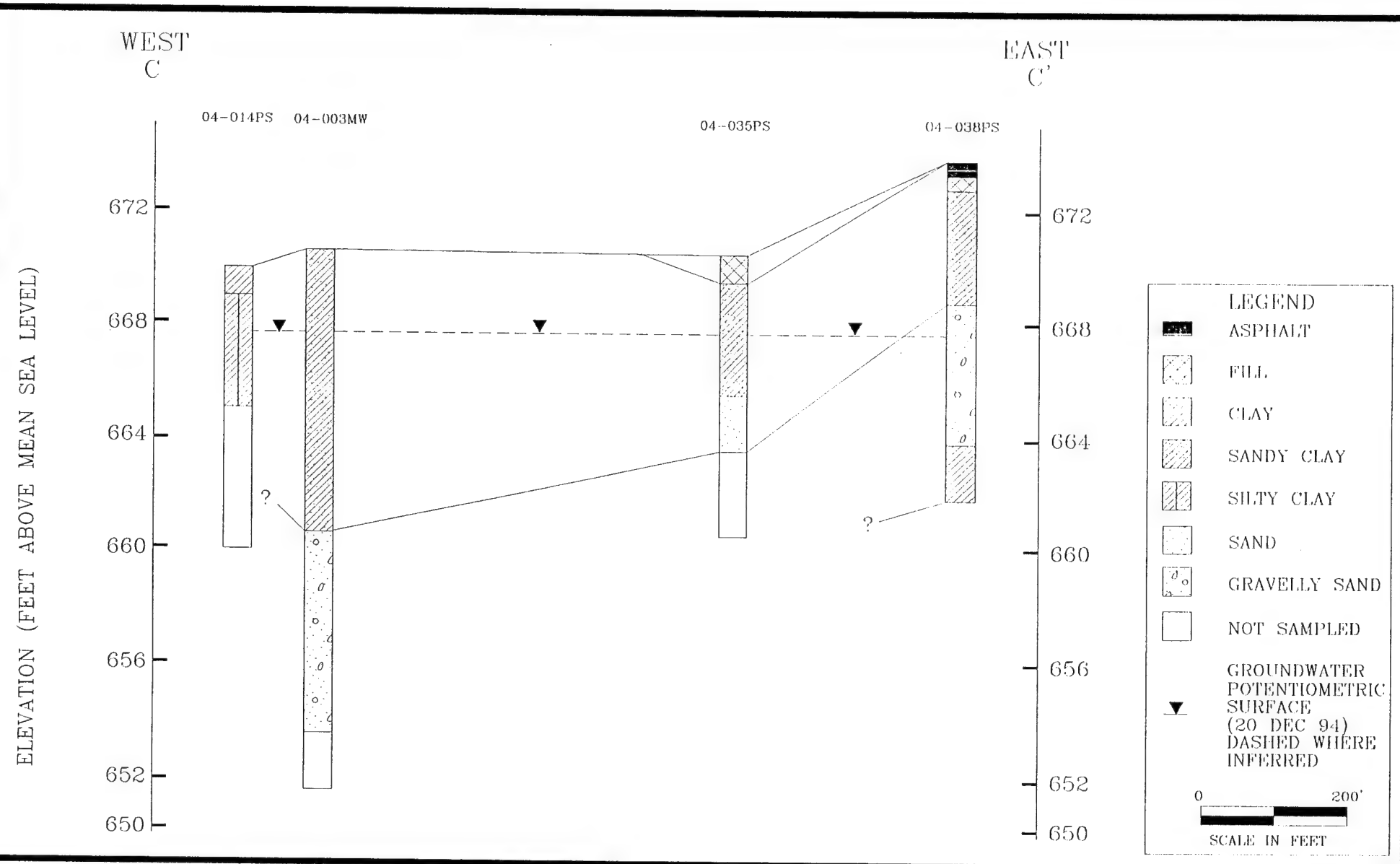

FIGURE 5.5

GEOLOGIC CROSS-SECTION C-C'
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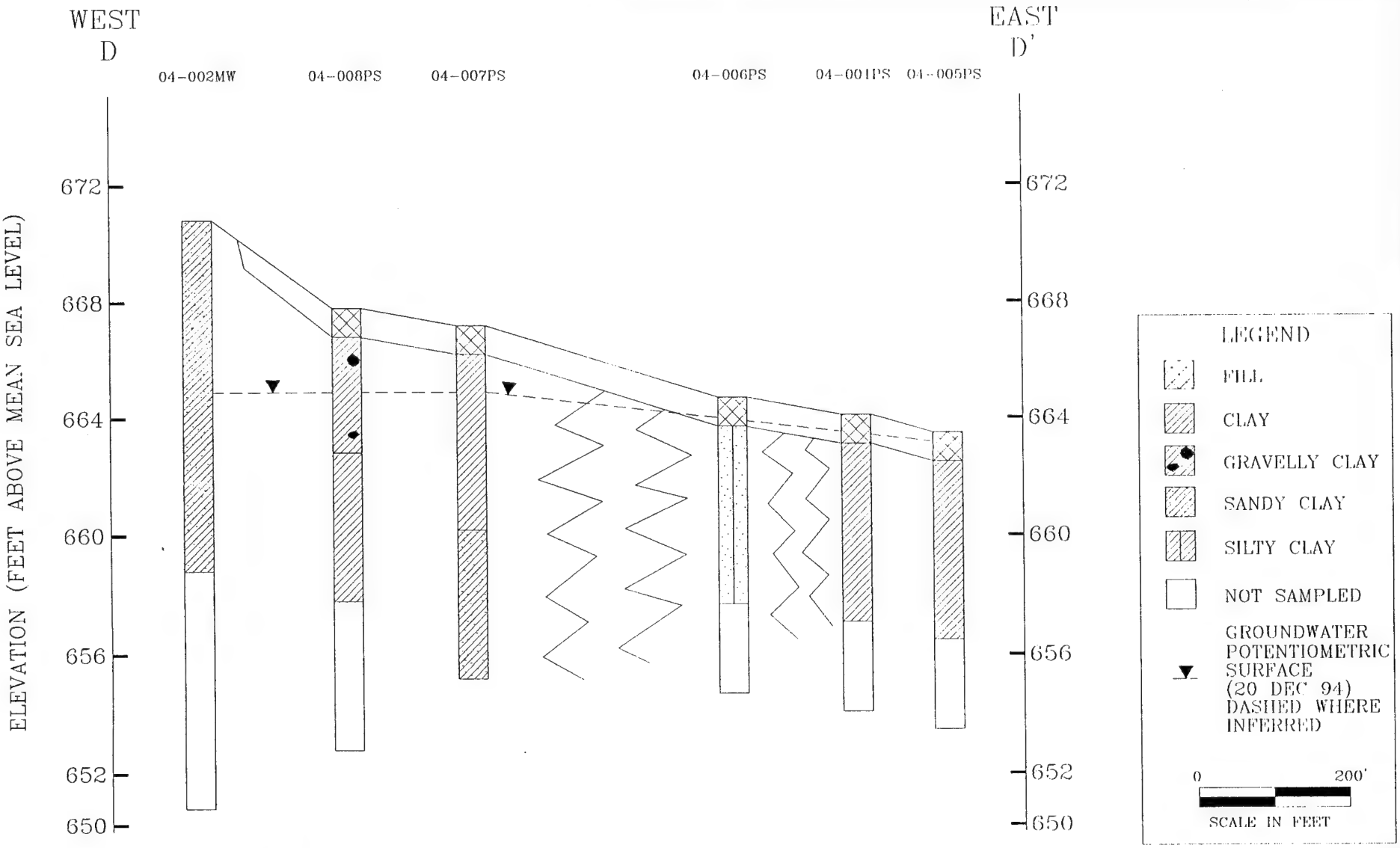

FIGURE 5.6

GEOLOGIC CROSS-SECTION D-D'
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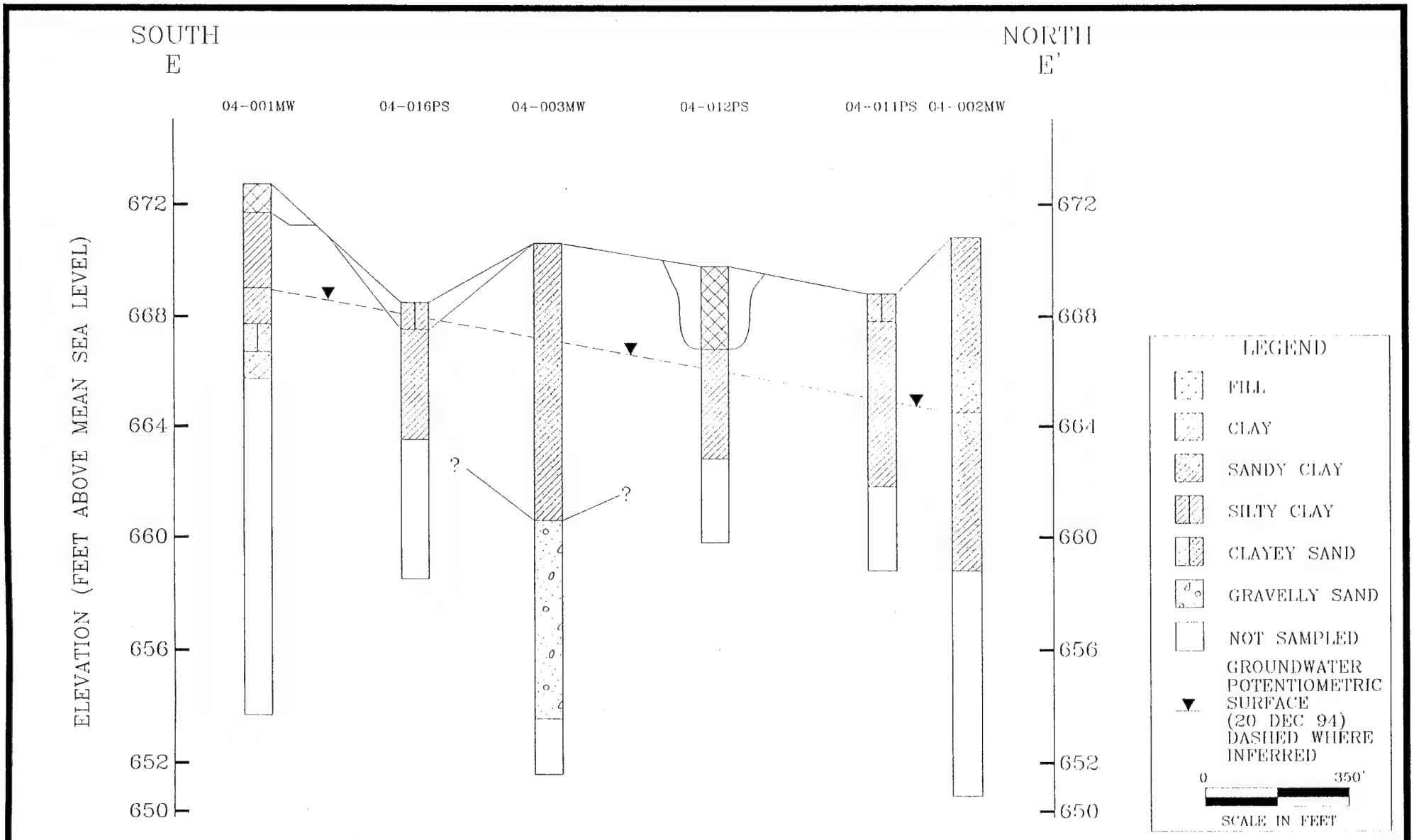

FIGURE 5.7

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GEOLOGIC CROSS-SECTION E-E'

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Table 5.2
Soil Sampling and Analytical Program for IRP Site No. 4
128th ARW, General Billy Mitchell Field ANGB, Milwaukee, Wisconsin

Borehole Number	Sample Depth (ft BLS)	Additional Samples	Soil Analyses and Methods					
			VOCs (SW8020)	PAH (SW8310)	WDNR GRO	WDNR DRO	Lead (SW6010)	Lead (EPA239.2)
04-001PZ	1 - 3 5 - 7		X X	X NS	X X	X X	X NS	NA
04-002PZ	1 - 3 5 - 7		X X	X X	X X	X X	X X	NA
04-003PZ	1 - 3 3 - 5 5 - 7	FD	X X X	X NS X	X X X	X X X	X NS X	NA
04-004PZ	1 - 3 5 - 7 8 - 10		X X X	X X X	X X X	X X X	X X X	NA
04-001PS	1 - 3 5 - 7		X X	X X	X X	X X	X X	NA
04-002PS	1 - 3 5 - 7		X X	X X	X X	X X	X X	NA
04-003PS	1 - 3 5 - 7		X X	X X	X X	X X	X X	NA
04-004PS	1 - 3		X	X	X	X	X	NA
04-005PS	1 - 3 5 - 7		X X	X X	X X	X X	X X	NA
04-006PS	1 - 3 5 - 7		X X	X X	X X	X X	X X	NA
04-007PS	1 - 3 5 - 7		X NS	X X	X X	X X	X X	NA
04-008PS	1 - 3 8 - 10		X X	X X	X X	X X	X X	NA

Table 5.2 (Continued)
Soil Sampling and Analytical Program for IRP Site No. 4
128th ARW, General Billy Mitchell Field ANGB, Milwaukee, Wisconsin

Borehole Number	Sample Depth (ft BLS)	Additional Samples	Soil Analyses and Methods					
			VOCs (SW8020)	PAH (SW8310)	WDNR GRO	WDNR DRO	Lead (SW6010)	Lead (EPA239.2)
04-009PS	1 - 3 5 - 7		X X	X X	X X	X X	X X	NA
04-010PS	1 - 3 3 - 5 5 - 7 8 - 10	FD	X X X X	NS NS X X	X X NS NS	X X X X	NS X X X	NA
04-011PS	1 - 3 5 - 7		X X	X X	X X	X X	X X	NA
04-012PS	5 - 7		X	NS	X	X	NS	NA
04-013PS	1 - 3 3 - 5 5 - 7		X X X	X X NS	X X X	X X X	X X NS	NA
04-014PS	1 - 3 7 - 9		X X	X X	X X	X X	X X	NA
04-015PS	1 - 3 3 - 5		X X	X X	X X	X X	X X	NA
04-016PS	1 - 3		X	X	X	X	X	NA
04-017PS	3 - 5		X	X	X	X	X	NA
04-018PS	1 - 3 5 - 7		X X	X X	X X	X X	X X	NA
04-019PS	1 - 3 5 - 7		X X	X X	X X	X X	X X	NA
04-020PS	1 - 3 5 - 7		X X	X X	X X	X[1] NS	X X	NA

Table 5.2 (Continued)
Soil Sampling and Analytical Program for IRP Site No. 4
128th ARW, General Billy Mitchell Field ANGB, Milwaukee, Wisconsin

Borehole Number	Sample Depth (ft BLS)	Additional Samples	Soil Analyses and Methods					
			VOCs (SW8020)	PAH (SW8310)	WDNR GRO	WDNR DRO	Lead (SW6010)	Lead (EPA239.2)
04-021PS	1 - 3 5 - 7		X X	X X	X X	X X	X X	NA
04-022PS	1 - 3 5 - 7		X X	X X	X X	X X	X X	NA
04-023PS	1 - 3 3 - 5 5 - 7		X X X	X X X	X X X	X[1] X[1] X[1]	X X X	NA
04-024PS	1 - 3 3 - 5		X X	X X	X X	X X	X X	NA
04-025PS	1 - 3 3 - 5 10 - 12	FD	X X X	X X X	X X X	X X X	X X X	NA
04-026PS	1 - 3 5 - 7		X X	NS X	NS X	NS X	NS X	NA
04-027PS	1 - 3 5 - 7		–[2] X	–[2] X	X[1] X	X[1] X[1]	–[2] X	NA
04-028PS	1 - 3 5 - 7		X X	X X	X X	X[1] X[1]	X X	NA
04-029PS	1 - 3 5 - 7		X X	X X	X X	X X	X X	NA
04-030PS	1 - 3 5 - 7		X X	X X	X X	X X	X X	NA
04-031PS	1 - 3 5 - 7		X X	X X	X X	X NS	X X	NA

Table 5.2 (Continued)
Soil Sampling and Analytical Program for IRP Site No. 4
128th ARW, General Billy Mitchell Field ANGB, Milwaukee, Wisconsin

Borehole Number	Sample Depth (ft BLS)	Additional Samples	Soil Analyses and Methods					
			VOCs (SW8020)	PAH (SW8310)	WDNR GRO	WDNR DRO	Lead (SW6010)	Lead (EPA239.2)
04-032PS	1 - 3		X	X	X	X	X	NA
04-033PS	1 - 3 3 - 5		X X	X X	X X	X X	X X	NA
04-034PS	1 - 3 3 - 5 5 - 7		X X X	X X X	X X X	X X X	X X X	NA
04-035PS	1 - 3 5 - 7		X X	X NS	X X	X X	X NS	NA
04-036PS	1 - 3		X	X	X	X	X	NA
04-037PS	1 - 3 5 - 7		X X	X X	X X	X X	X X	NA
04-038PS	1 - 3 5 - 7 10 - 12	MS/MSD	X X X	X X X	X X X	X X X	X X X	NA

Table 5.2 (Concluded)
Soil Sampling and Analytical Program for IRP Site No. 4
128th ARW, General Billy Mitchell Field ANGB, Milwaukee, Wisconsin

Borehole Number	Sample Depth (ft BLS)	Additional Samples	Soil Analyses and Methods					
			VOCs (SW8020)	PAH (SW8310)	WDNR GRO	WDNR DRO	Lead (SW6010)	Lead (EPA239.2)
		Equipment Blanks (6)	X	X	X	X		
		Field Blanks (4)	X	X	X	X		X
		Trip Blanks (14)	X					X

ft BLS – feet Below Land Surface.
VOCs – Volatile Organic Compounds.
PAH – Polynuclear Aromatic Hydrocarbons.
WDNR GRO – Wisconsin Department of Natural Resources Gasoline Range Organics.
WDNR DRO – Wisconsin Department of Natural Resources Diesel Range Organics.
EPA – United States Environmental Protection Agency.
PS – Push-Sample.
PZ – Piezometer.
NS – Insufficient soil recovery for analysis of this parameter.
[1]Hold time exceeded for DRO analysis; resampled.
[2]No recovery occurred for initial sampling event.
FD – Field Duplicate.
MS/MSD – Matrix Spike/Matrix Spike Duplicate.
IRP – Installation Restoration Program.
NA – Not Analyzed.

04-020PS, 04-023PS, 04-027PS, and 04-028PS. Corrective action was initiated and re-sampling and analyses was completed.

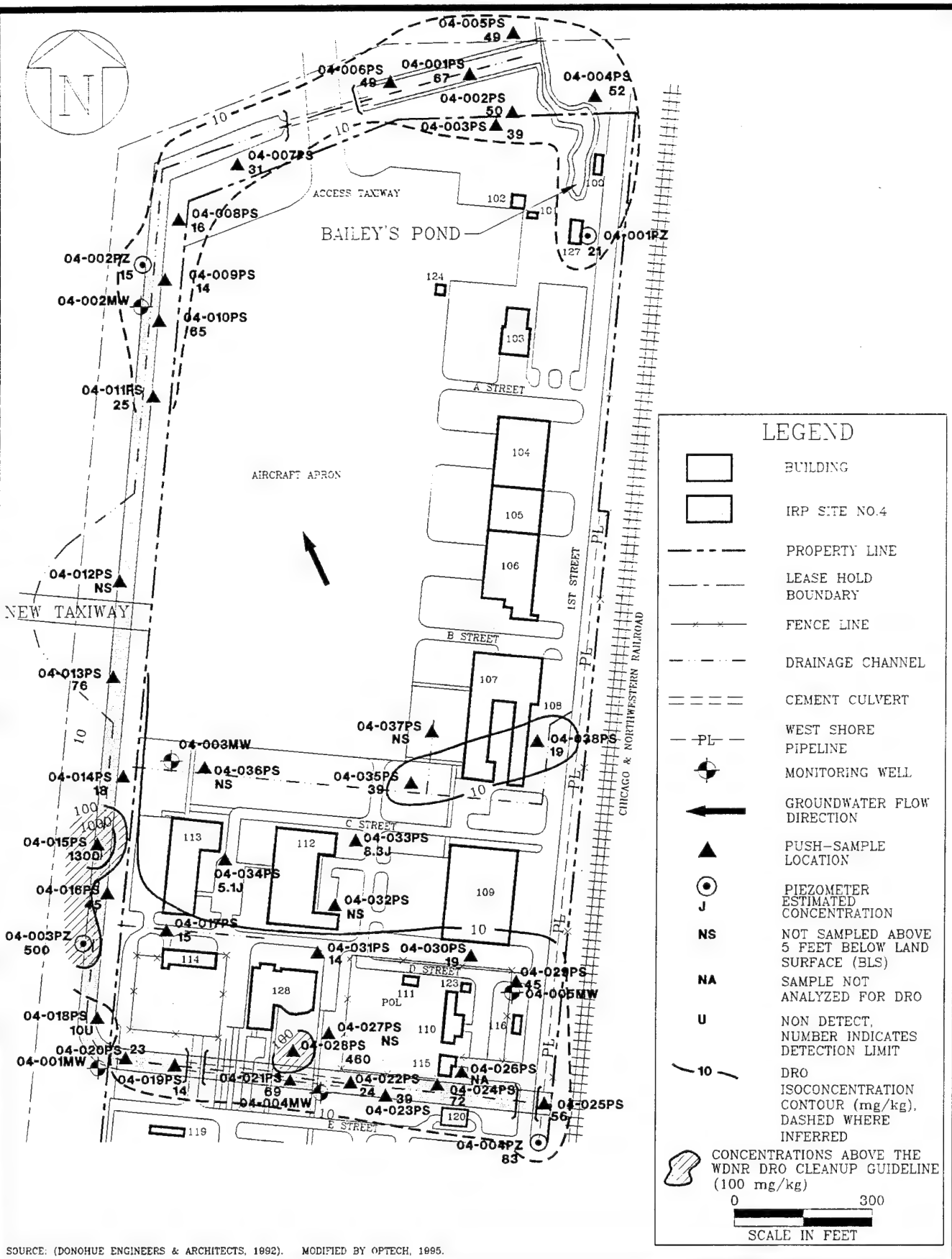
VOC soil surrogate recoveries were within acceptable limits for meeting QA/QC criteria except for samples 04-010PS (1 - 3 feet BLS) and 04-006PS (5 - 7 feet BLS), which exhibited low recovery. All soil sample intervals obtained from push-sample location 04-010PS exhibited high surrogate recoveries for VOC analyses. Corrective actions were implemented by re-analyzing the samples. Similar results were obtained by the re-analysis.

5.2.2.3.1 DRO and GRO Contamination

DRO detected in soil at IRP Site No. 4 are shown in Table 5.3. DRO was detected in 72 soil samples at concentrations ranging from 5.1 to 1,700 mg/kg, with the highest concentration detected in sample 04-003PZ (5 - 7 feet BLS). Push-sample soil locations 04-018PS, 04-014PS, 04-015PS, and push-sample piezometer 04-003PZ, located west of Buildings 113 and 114, had maximum DRO concentrations of 150, 300, 1,300, and 1,700 mg/kg, respectively. Push-sample soil location 04-028PS, located south of Building 128, had a maximum DRO concentration of 790 mg/kg. These samples exceed the WDNR cleanup guideline of 100 mg/kg for DRO in soil (WDNR, 1992). Figures 5.8 and 5.9 show DRO soil sample concentrations in samples collected from 1 to 5 feet BLS and those collected below 5 feet BLS, respectively.

GRO detected in soil at IRP Site No. 4 are shown in Table 5.3. GRO compounds were detected in 13 soil samples at concentrations ranging from 8.0 to 4,600 mg/kg, with the highest concentration detected in sample 04-003PZ (5 - 7 feet BLS). Push-sample soil locations 04-014PS, 04-015PS, and push-sample piezometer 04-003PZ, located west of Building 114, had maximum GRO concentrations of 2,300, 1,000, and 4,600 mg/kg, respectively. Push-sample soil location 04-028PS, located south of Building 128, had a maximum GRO concentration of 1,600 mg/kg. These samples exceed the WDNR cleanup guideline of 100 mg/kg for GRO in soil. Figures 5.10 and 5.11 show GRO soil sample concentrations in samples collected from 1 to 5 feet BLS and those collected below 5 feet BLS, respectively.

GRO and DRO are the two primary methods employed for fuel hydrocarbon determination. Each method encompasses a range of carbon chains that constitute the primary components of the relevant fuel in question. Gasolines are very sophisticated fuels and are often blends of refinery products. Gasoline contains hydrocarbon compounds, the majority of which elute on the GC from c4 to c10, with a maximum near c5. Diesel contains hydrocarbon compounds, the majority of which elute on the GC from c8 to c19.



SOURCE: (DONOHUE ENGINEERS & ARCHITECTS, 1992). MODIFIED BY OPTECH, 1995.

FIGURE 5.8

BILLYMIT\BM-BORE

DIESEL RANGE ORGANICS DETECTED IN SOIL SAMPLES BETWEEN 1 AND 5 FEET BLS

128th ARW, Gen. Billy Mitchell Field ANGB
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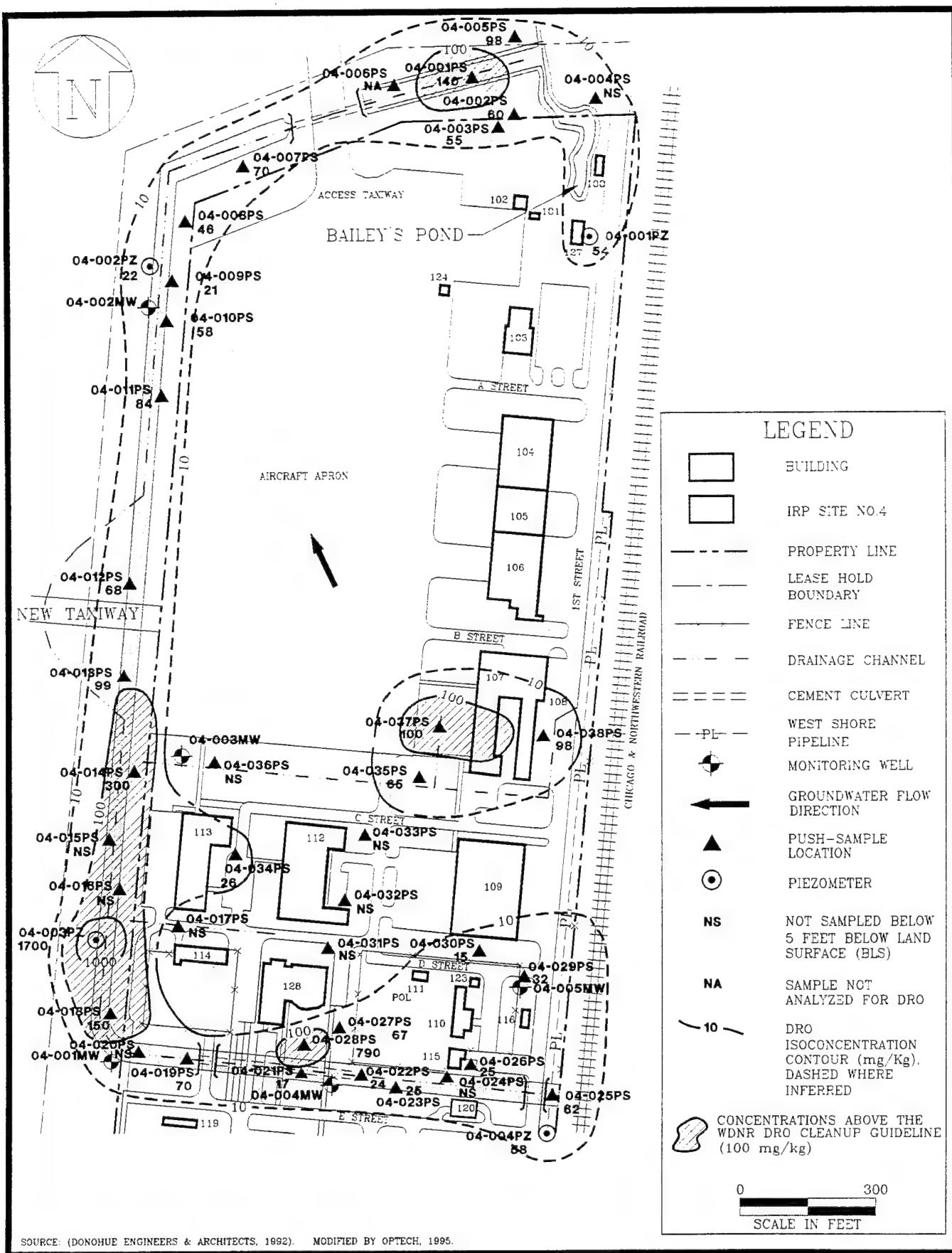

SOURCE: (DONOHUE ENGINEERS & ARCHITECTS, 1992). MODIFIED BY OPTECH, 1995.

FIGURE 5.9

BILLYMIT\BM-BORE

DIESEL RANGE ORGANICS DETECTED IN SOIL SAMPLES BELOW 5 FEET BLS

128th ARW, Gen. Billy Mitchell Field ANGB
Milwaukee, Wisconsin

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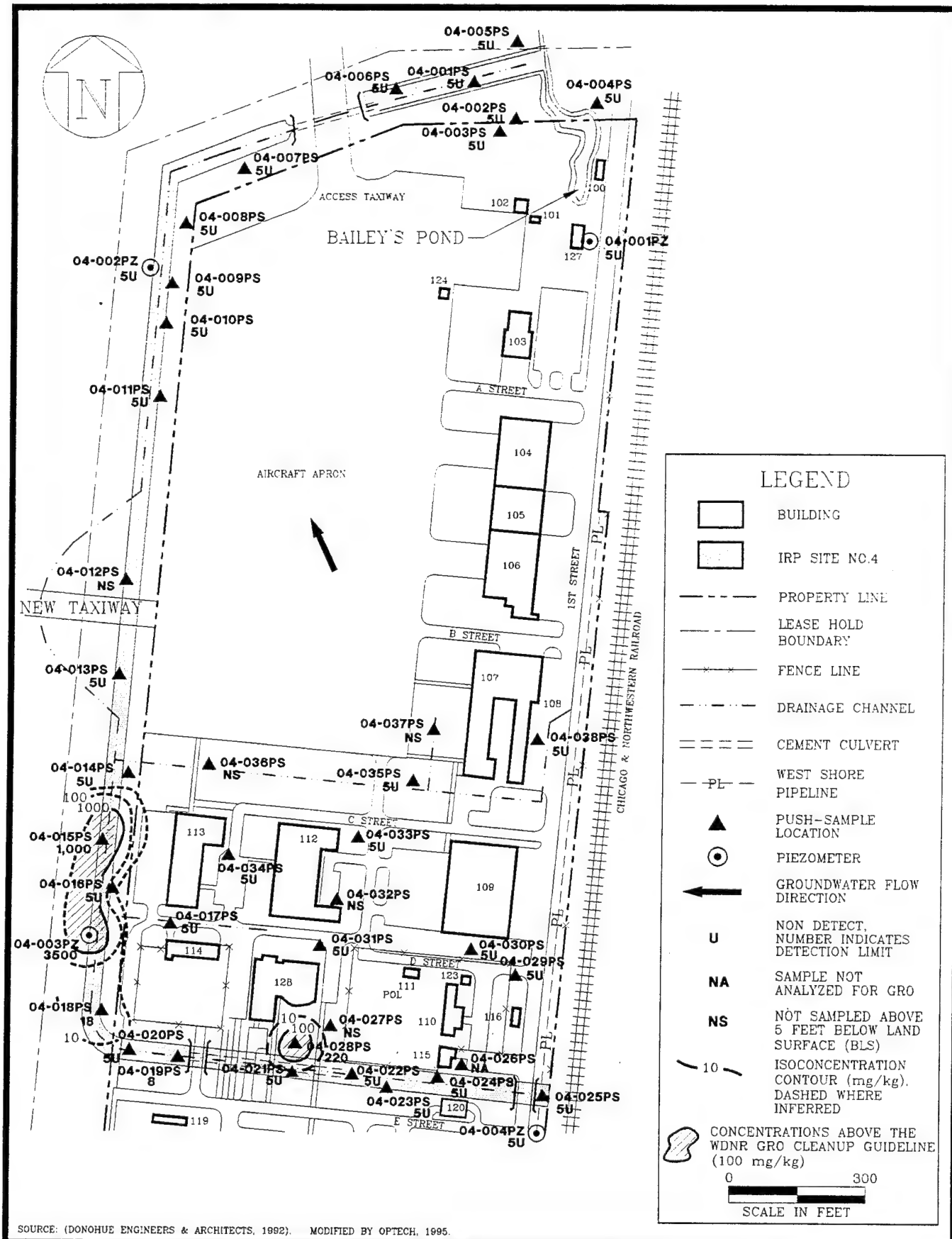

SOURCE: (DONOHUE ENGINEERS & ARCHITECTS, 1992). MODIFIED BY OPTECH, 1995.

FIGURE 5.10

BILLYMIT\BM-BORE2

GASOLINE RANGE ORGANICS DETECTED IN SOIL SAMPLES BETWEEN 1 AND 5 FEET BLS

128th ARW, Gen. Billy Mitchell Field ANGB
Milwaukee, Wisconsin

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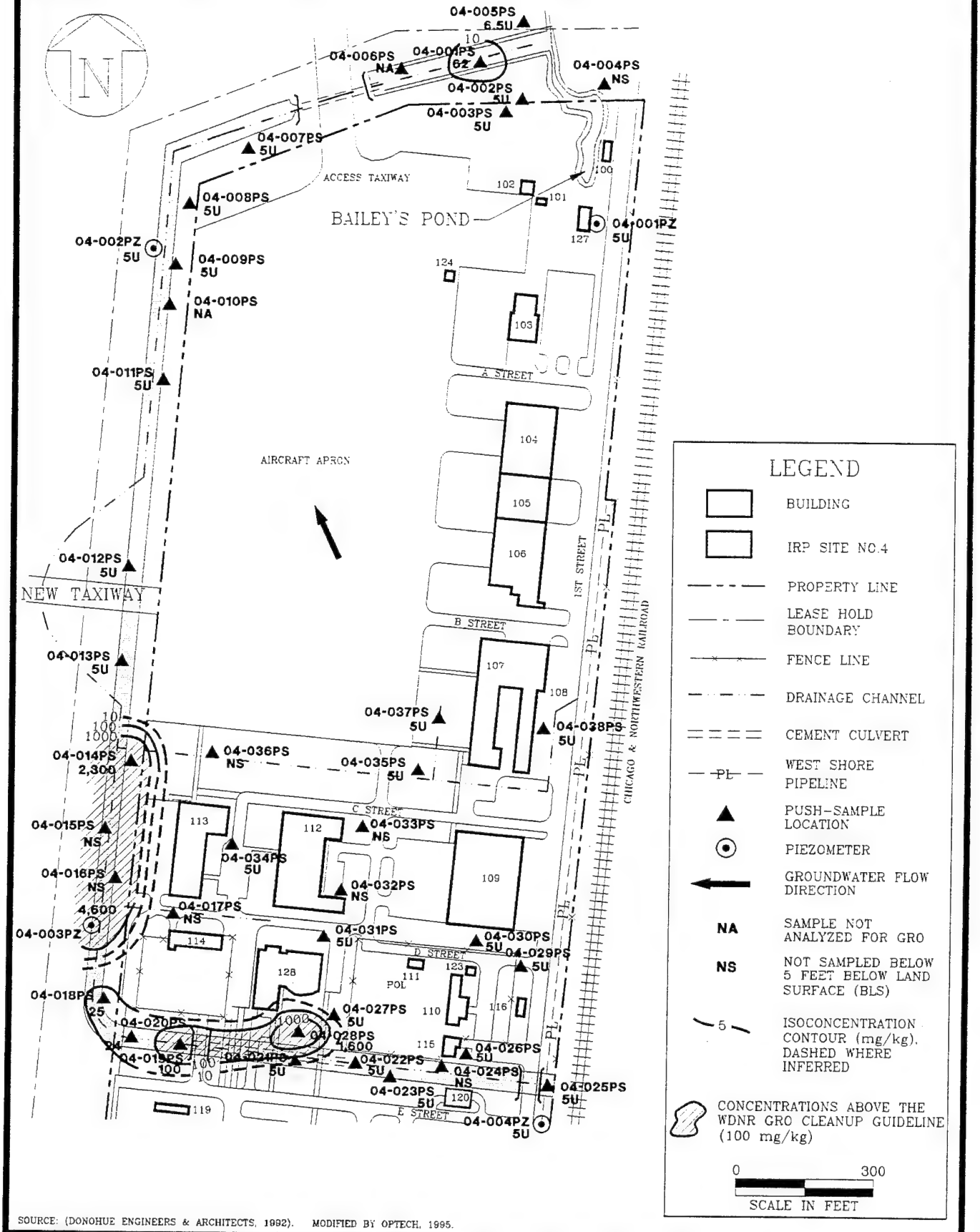

SOURCE: (DONOHUE ENGINEERS & ARCHITECTS, 1992). MODIFIED BY OPTECH, 1995.

FIGURE 5.11

BILLYMIT\BM-BORE2

GASOLINE RANGE ORGANICS
DETECTED IN SOIL
SAMPLES BELOW 5 FEET BLS
128th ARW, Gen. Billy Mitchell Field ANGB
Milwaukee, Wisconsin

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Table 5.3
Diesel and Gasoline Range Organics Detected in Soil Samples Collected at IRP Site No. 4
128th ARW, General Billy Mitchell Field ANGB, Milwaukee, Wisconsin

Sample Location/Interval (feet BLS)	Analyte	
	Diesel Range Organics (mg/kg)	Gasoline Range Organics (mg/kg)
04-001PZ 1 - 3	21	5U
04-001PZ 5 - 7	54	5U
04-002PZ 1 - 3	15	5U
04-002PZ 5 - 7	22	5U
04-003PZ 1 - 3	62LB	5U
04-003PZ 3 - 5 FD	**500LB**	**3,500**
04-003PZ 5 - 7	**1,700LB**	**4,600**
04-004PZ 1 - 3	83	5U
04-004PZ 5 - 7	26	5U
04-004PZ 8 - 10	58	5U
04-001PS 1 - 3	67	5U
04-001PS 5 - 7	**140**	62HB
04-002PS 1 - 3	50	5U
04-002PS 5 - 7	60	5U
04-003PS 1 - 3	39	5U
04-003PS 5 - 7	55	5U
04-004PS 1 - 3	52	5U
04-005PS 1 - 3	49	5U
04-005PS 5 - 7	98	6.5U
04-006PS 1 - 3	49	5U
04-006PS 5 - 7	–	–
04-007PS 1 - 3	31	5U
04-007PS 5 - 7	70	5U
04-008PS 1 - 3	16	5U
04-008PS 8 - 10	46	5U
04-009PS 1 - 3	14	5U
04-009PS 5 - 7	21	5U
04-010PS 1 - 3	65HB	5U
04-010PS 3 - 5 FD	52HB	5U
04-010PS 5 - 7	30	–
04-010PS 8 - 10	58	–
04-011PS 1 - 3	25	5U
04-011PS 5 - 7	84	5U

Table 5.3 (Continued)
Diesel and Gasoline Range Organics Detected in Soil Samples Collected at IRP Site No. 4
128th ARW, General Billy Mitchell Field ANGB, Milwaukee, Wisconsin

Sample Location/Interval (feet BLS)	Analyte	
	Diesel Range Organics (mg/kg)	Gasoline Range Organics (mg/kg)
04-012PS 5 - 7	68	5U
04-013PS 1 - 3 04-013PS 3 - 5 04-013PS 5 - 7	76 56 99	5U 5U 5U
04-014PS 1 - 3 04-014PS 7 - 9	18 **300**	5U **2,300HB**
04-015PS 1 - 3 04-015PS 3 - 5	19 **1,300LB**	9.3HB **1,000**
04-016PS 1 - 3	45	5U
04-017PS 3 - 5	15	5U
04-018PS 1 - 3 04-018PS 5 - 7	10U **150**	18 25
04-019PS 1 - 3 04-019PS 5 - 7	14 70	8.0 100
04-020PS 1 - 3 04-020PS 5 - 7	23 –	5U 24
04-021PS 1 - 3 04-021PS 5 - 7	69 17	5U 5U
04-022PS 1 - 3 04-022PS 5 - 7	24 24	5U 5U
04-023PS 3 - 5 04-023PS 5 - 7	39 25	5U 5U
04-024PS 3 - 5	72	5U
04-025PS 1 - 3 04-025PS 3 - 5 FD 04-025PS 10 - 12	56 10U 62	5U 5U 5U
04-026PS 1 - 3 04-026PS 5 - 7	– 25	– 5U
04-027PS 5 - 7	67	5U
04-028PS 1 - 3 04-028PS 5 - 7	**460LB** **790LB**	**220HB** **1,600**

Table 5.3 (Concluded)
Diesel and Gasoline Range Organics Detected in Soil Samples Collected at IRP Site No. 4
128th ARW, General Billy Mitchell Field ANGB, Milwaukee, Wisconsin

Sample Location/Interval (feet BLS)	Analyte	
	Diesel Range Organics (mg/kg)	Gasoline Range Organics (mg/kg)
04-029PS 1 - 3	45	5U
04-029PS 5 - 7	32	5U
04-030PS 1 - 3	19	5U
04-030PS 5 - 7	15	5U
04-031PS 1 - 3	14	5U
04-031PS 5 - 7	–	5U
04-033PS 1 - 3	8.3J	5U
04-034PS 3 - 5	5.1J	5U
04-034PS 5 - 7	26	5U
04-035PS 1 - 3	39	5U
04-035PS 5 - 7	65	5U
04-037PS 5 - 7	**100**	5U
04-038PS 1 - 3	19	5U
04-038PS 5 - 7 MS/MSD	30	5U
04-038PS 10 - 12	98	5U
WDNR Cleanup Guidelines	100	100

IRP – Installation Restoration Program.
BLS – Below Land Surface.
mg/kg – milligrams per kilogram.
PZ – Piezometer.
PS – Push-Sample.
LB – Low boiling point components are present in sample.
FD – Field Duplicate.
MS/MSD – Matrix Spike/Matrix Spike Duplicate.
Bold values exceed WDNR cleanup guidelines.
Dup – Duplicate.
U – Compound analyzed for but not detected. Number indicates the detection limit.
"–" – Compound not analyzed.
HB – High boiling point hydrocarbons are present in sample.
J – Detected below PQL; therefore, result is an estimated concentration.
PQL – Practical Quantitation Limit.

Because every gasoline component may not fall within the GRO range, and all diesel components may not fall within the range of DRO, additional information is provided with the analysis results. The "HB" and "LB" flags are applied to the reported results to indicate the presence of high boiling point compounds and low boiling compounds, respectively. This characteristic results in the possibility that a DRO result is reported that may not be entirely composed of DRO components. The application of the "LB" flag might support this assumption. Because

the GRO and DRO ranges slightly overlap, some GRO components can be quantified within the DRO range. The DRO results with the "HB" flags may not be contributions from gasoline components, and are of unknown nature (Novotny, 1995).

With spills that have occurred in the past, fingerprinting the components, and then analyzing for the proper ranges of petroleum products being investigated, is much more difficult but would be a more efficient method of investigation for further work to be performed. In these cases the sampling plan is of the utmost importance. Samples must be taken and then analyzed to show a step-by-step trail of the contamination back to the source. The steps must be small enough to have comparable chemical signatures between sampling locations. Sampling must also be done to show that negative results or non-matches are found when moving away from the actual contamination path (Andrew and Bruya; Christensen and Larsen).

5.2.2.3.2 VOC Contamination

VOCs detected in soil samples collected at IRP Site No. 4, shown in Table 5.4, were as follows: benzene, 0.6 to 25,000 micrograms per kilogram (μg/kg); toluene, 1.0 to 130,000 μg/kg; ethylbenzene, 1.1 to 68,000 μg/kg; total xylenes, 1.2 to 300,000 μg/kg; and 1,2,4-trimethylbenzene, 1.3 to 120,000 μg/kg. The highest concentration was detected in sample 04-003PZ (5 - 7 feet BLS). The VOC 1,3,5-trimethylbenzene was detected at concentrations ranging from 1.2 to 350,000 μg/kg, with the highest concentration detected in sample 04-020PS (5 - 7 feet BLS). Figure 5.12 shows benzene concentrations in soil samples below 5 feet BLS.

The WDNR cleanup guideline of 5.5 μg/kg for benzene in soil was exceeded in samples collected from push-sample soil locations 04-003PZ, 04-005PS, 04-012PS, 04-014PS, 04-015PS, 04-016PS, and 04-019PS. Similarly, WDNR cleanup guidelines of 1,500 μg/kg, 2,900 μg/kg, and 4,100 μg/kg for toluene, ethylbenzene, and total xylenes were exceeded in samples collected from push-sample soil locations 04-003PZ, 04-014PS, 04-015PS, 04-016PS, 04-020PS, and 04-028PS. There are currently no WDNR cleanup guidelines for the VOCs 1,3,5-trimethylbenzene and 1,2,4-trimethylbenzene. Sample 04-020PS inaccurately displayed a value of 1,000U for benzene on the original report forms. After additional evaluation of the sample's raw data, the reported value was confirmed to read 7,600 μg/kg for benzene.

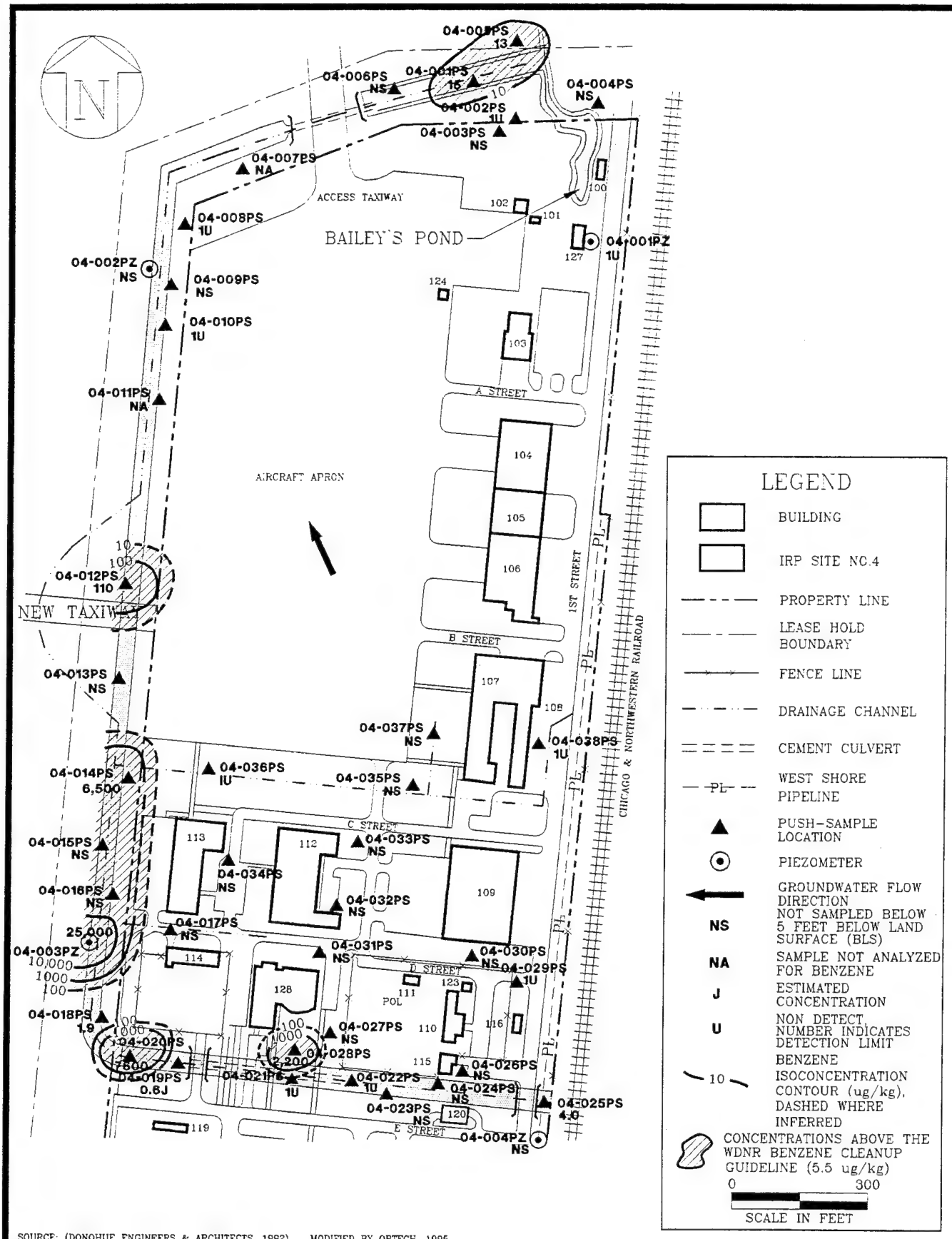
Table 5.4
Volatile Organic Compounds Detected in Soil Samples Collected at IRP Site No. 4
128th ARW, General Billy Mitchell Field ANGB, Milwaukee, Wisconsin

Sample Location/Interval (feet BLS)	VOCs (µg/kg)					
	Benzene	Toluene	Ethylbenzene	Total Xylenes	1,3,5-Trimethylbenzene	1,2,4-Trimethylbenzene
04-001PZ 5 - 7	1U	1.1	1U	1.2	1U	1U
04-002PZ 1 - 3	1U	1.2	1U	1U	1U	1U
04-003PZ 3 - 5 FD	1,000U	**6,700**	**8,900**	**40,000**	18,000	34,000
04-003PZ 5 - 7	**25,000**	**130,000**	**68,000**	**300,000**	45,000	120,000
04-004PZ 1 - 3	1U	4.1	9.5	1U	1U	1U
04-001PS 5 - 7	**15**	2U	2U	2U	2U	2U
04-002PS 5 - 7	1U	1.5	1U	1U	1U	1U
04-003PS 1 - 3	1U	1.3	1U	1U	1U	1U
04-005PS 1 - 3	**6.8**	16	53	120	39	88
04-005PS 5 - 7	**13**	2U	2U	2U	2U	2U
04-006PS 1 - 3	1U	1U	1U	1.4	2.6	5.9
04-010PS 1 - 3	1U	1.2	1U	1.9	1.3	1.8
04-010PS 8 - 10	1U	1U	1.1	5.3	1.2	5.1
04-012PS 5 - 7	**110**	2.5U	2.5U	2.5U	2.5U	2.5U
04-013PS 1 - 3	1U	2.4	1.0	3.8	8.7	4.7
04-014PS 7 - 9	**6,500**	**4,400**	**24,000**	**46,000**	46,000	110,000
04-015PS 1 - 3	**9.3**	35	120	520	46	160
04-015PS 3 - 5	**2,900**	**26,000**	**41,000**	**190,000**	26,000	68,000
04-016PS 1 - 3	**1,500**	890	**4,400**	**6,300**	290	550
04-018PS 1 - 3	0.8J	1U	4.3	2.2	1U	1U
04-018PS 5 - 7	1.9	1U	2.5	2.7	1U	1U

Table 5.4 (Concluded)
Volatile Organic Compounds in Soil Samples Collected at IRP Site No. 4
128th ARW, General Billy Mitchell Field ANGB, Milwaukee, Wisconsin

Sample Location/Interval (feet BLS)	VOCs (µg/kg)					
	Benzene	Toluene	Ethylbenzene	Total Xylenes	1,3,5-Trimethylbenzene	1,2,4-Trimethylbenzene
04-019PS 1 - 3	**310**	620	210	770	120	330
04-019PS 5 - 7	0.6J	1.9	1.8	4.7	1.4	5.1
04-020PS 1 - 3	1U	1U	1U	1U	1U	1.6
04-020PS 5 - 7	**7,600**	**14,000**	**42,000**	**140,000**	350,000	58,000
04-021PS 1 - 3	1U	1.1	1U	1.2	1U	4.4
04-021PS 5 - 7	1U	1.8	1U	1U	1U	1.3
04-022PS 5 - 7	1U	1.2	1U	1.8	1.5	1.9
04-025PS 1 - 3	1U	1U	1U	1U	5.3	1U
04-025PS 3 - 5 FD	1.0	1.1	1U	1U	1U	1U
04-025PS 10 - 12	4.0	4.0	1.3	6.0	1.4	4.2
04-028PS 1 - 3	1U	1.3	1U	1U	1U	1U
04-028PS 5 - 7	**2,200**	**4,100**	**26,000**	**110,000**	29,000	74,000
04-029PS 5 - 7	1U	3.5	1U	1U	1U	1U
04-036PS 1 - 3	1U	1.1	1U	1U	1U	1U
04-038PS 1 - 3	1U	1.0	1U	1U	1U	1.8
04-038PS 10 - 12	1U	2.2	1U	1U	1U	1U
WDNR Cleanup Guidelines	5.5	1,500	2,900	4,100	NA	NA

VOCs – Volatile Organic Compounds.
IRP – Installation Restoration Program.
BLS – Below Land Surface.
µg/kg – micrograms per kilogram.
PS – Push-Sample.
PZ – Piezometer.
FD – Field Duplicate.
PQL – Practical Quantitation Limit.
J – Detected below PQL; therefore, result is an estimated concentration.
U – Compound analyzed for but not detected. Number indicates the detection limit.
NA – Not Available.
WDNR – Wisconsin Department of Natural Resources.
Bold values exceed WDNR cleanup guidelines.



SOURCE: (DONOHUE ENGINEERS & ARCHITECTS, 1992). MODIFIED BY OPTECH, 1995.

FIGURE 5.12

BILLYMIT\BM-BORE2

BENZENE DETECTED IN SOIL SAMPLES BELOW 5 FEET BLS

128th ARW, Gen. Billy Mitchell Field ANGB
Milwaukee, Wisconsin

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5.2.2.3.3 PAH Contamination

Fourteen PAH were detected in soil samples collected from IRP Site No. 4, as reported in Table 5.5. WDNR cleanup guidelines for PAH in soil are determined for individual sites through the use of risk assessment procedures. Naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene were detected only in sample 04-005PS (1 - 3 feet BLS) at concentrations of 5,490, 2,370, and 8,780 µg/kg, respectively. Phenanthrene, anthracene, and benzo(b)fluoranthene were detected only in sample 04-025PS (1 - 3 feet BLS) at concentrations of 7,990, 2,260, and 1,620 µg/kg, respectively. Benzo(ghi)perylene and indeno(1,2,3-cd)pyrene were detected only in sample 04-013PS (1 - 3 feet BLS) at concentrations of 9,180 and 3,830 µg/kg, respectively. Fluoranthene, pyrene, benzo(a)anthracene, and chrysene were detected at concentrations ranging from 344 to 15,300 µg/kg, 18.6 to 8,150 µg/kg, 8.6 to 3,740 µg/kg, and 5.7 to 2,530 µg/kg, respectively, with the highest concentration detected in sample 04-025PS (1 - 3 feet BLS). Benzo(k)fluoranthrene and benzo(a)pyrene were detected at concentrations ranging from 235 to 6,060 µg/kg, and 395 to 11,200 µg/kg, respectively, with the highest concentration detected in sample 04-013PS (1 - 3 feet BLS).

Table 5.5
Polynuclear Aromatic Hydrocarbons Detected
in Soil Samples Collected at IRP Site No. 4
128th ARW, General Billy Mitchell Field ANGB, Milwaukee, Wisconsin

PAH (µg/kg)	Sample Location/Interval (feet BLS)					
	04-005PS 1 - 3	04-008PS 1 - 3	04-013PS 1 - 3	04-013PS 3 - 5	04-025PS 1 - 3	04-025PS 3 - 5
Naphthalene	5,490	4U	20U	10U	50U	4U
Phenanthrene	7U	1.4U	7U	3.5U	7,990	1.4U
Anthracene	2U	0.4U	2U	1U	2,260	0.4U
Fluoranthene	411	1.6U	8U	4U	15,300	344
Pyrene	44.2	18.6	3U	1.5U	8,150	200
Benzo(a)anthracene	16U	8.6	16U	750	3,740	3.2U
Chrysene	40.1	5.7	10U	532	2,530	2.0U
Benzo(b)fluoranthene	10U	2U	10U	5U	1,620	2.0U
Benzo(k)fluoranthrene	2U	0.4U	6,060	235	995	0.4U
Benzo(a)pyrene	1U	0.2U	11,200	395	2,250	0.2U
Benzo(ghi)perylene	5U	1U	9,180	2.5U	1,140	1.0U
Indeno(1,2,3-cd)pyrene	5U	1U	3,830	2.5U	12.5U	1.0U
1-Methyl Naphthalene	2,370	2U	10U	5.0U	25U	2.0U
2-Methyl Naphthalene	8,780	2U	10U	5.0U	25U	2.0U

PAH(s) – Polynuclear Aromatic Hydrocarbon(s).
IRP – Installation Restoration Program.
µg/kg – Micrograms per kilogram.
BLS – Below land surface.
PS – Push-Sample.
U – Compound analyzed for but not detected. Number indicates the detection limit.

5.2.2.3.4 Lead Contamination

Lead detected in soil samples is shown in Table 5.6. Lead was detected in 80 soil samples at concentrations ranging from 1.6 to 93 mg/kg, with the highest concentration detected in sample 04-001PZ (1 - 3 feet BLS). The WDNR cleanup guideline for lead at industrial areas is 500 mg/kg, and none of the samples exceeded this guideline.

5.2.3 Groundwater Investigation Findings

5.2.3.1 Push-Sample Piezometer Locations

Four push-sample piezometers were temporarily installed at the base to obtain groundwater screening samples for laboratory analysis and to aid in defining the vertical and horizontal extent of groundwater contamination. Soil samples were also used for characterizing site geology and subsurface soil conditions. The locations of the push-sample piezometers are shown in Figure 5.1.

5.2.3.2 Push-Sample Locations

Eight push-sample locations were advanced at the base to obtain "grab" groundwater screening samples for laboratory analysis and to aid in defining the vertical and horizontal extent of groundwater contamination. The push-sample soil locations are shown in Figure 5.1. The eight push-sample locations at which "grab" groundwater samples were collected include 04-001PS, 04-002PS, 04-003PS, 04-005PS, 04-006PS, 04-007PS, 04-008PS, and 04-009PS.

5.2.3.3 Monitoring Well Locations

During the field program, petroleum contamination was detected in groundwater screening samples and, therefore, monitoring wells were installed. The purpose of the monitoring wells was to obtain groundwater samples for laboratory analysis, to define any existing groundwater contamination, and to aid in defining groundwater flow direction and gradient. Soil samples were also used for characterizing site geology and subsurface soil conditions. The locations of the monitoring wells are shown in Figure 5.1.

Table 5.6
Lead Detected in Soil Samples Collected at IRP Site No. 4
128th ARW, General Billy Mitchell Field ANGB, Milwaukee, Wisconsin

Sample Location/ Interval (feet BLS)	Lead (mg/kg)	Sample Location/ Interval (feet BLS)	Lead (mg/kg)	Sample Location/ Interval (feet BLS)	Lead (mg/kg)
04-001PZ 1 - 3	93	04-011PS 1 - 3 04-011PS 5 - 7	8.4 7.8	04-026PS 5 - 7	1.6
04-002PZ 1 - 3 04-002PZ 5 - 7	14 7.4	04-013PS 1 - 3 04-013PS 3 - 5	14 22	04-027PS 5 - 7	4.4
04-003PZ 1 - 3 04-003PZ 5 - 7	9.0 20	04-014PS 1 - 3 04-014PS 7 - 9	15 50	04-028PS 1 - 3 04-028PS 1 - 3 04-028PS 5 - 7	48 12.9 11
04-004PZ 1 - 3 04-004PZ 5 - 7 04-004PZ 8 - 10	6.6 6.4 3.2	04-015PS 1 - 3 04-015PS 3 - 5	9.9 14	04-029PS 1 - 3 04-029PS 5 - 7	15 7.0
04-001PS 1 - 3 04-001PS 5 - 7	7.5 7.0	04-016PS 1 - 3	6.2	04-030PS 1 - 3 04-030PS 5 - 7	13 5.4
04-002PS 1 - 3 04-002PS 5 - 7	6.0 6.0	04-017PS 3 - 5	5.3	04-031PS 1 - 3 04-031PS 5 - 7	16 5.8
04-003PS 1 - 3 04-003PS 5 - 7	5.8 6.4	04-018PS 1 - 3 04-018PS 5 - 7	11 5.1	04-032PS 1 - 3	6.0
04-004PS 1 - 3	12	04-019PS 1 - 3 04-019PS 5 - 7	12 6.2	04-033PS 1 - 3 04-033PS 3 - 5	6.3 10
04-005PS 1 - 3 04-005PS 5 - 7	14 7.5	04-020PS 1 - 3 04-020PS 5 - 7	13 5.8	04-034PS 1 - 3 04-034PS 3 - 5 04-034PS 5 - 7	9.4 12 5.7
04-006PS 1 - 3 04-006PS 5 - 7	6.3 7.0	04-021PS 1 - 3 04-021PS 5 - 7	15 4.0	04-035PS 1 - 3	12
04-007PS 1 - 3 04-007PS 5 - 7	9.0 3.2	04-022PS 5 - 7 04-022PS 1 - 3	6.2 1.6	04-036PS 1 - 3	8.3
04-008PS 1 - 3 04-008PS 8 - 10	8.0 7.8	04-023PS 1 - 3 04-023PS 3 - 5 MS/MSD 04-023PS 5 - 7	12 10 2.7	04-037PS 1 - 3 04-037PS 5 - 7	9.6 25
04-009PS 1 - 3 04-009PS 5 - 7	7.9 7.1	04-024PS 1 - 3 04-024PS 3 - 5	9.9 5.6	04-038PS 1 - 3 04-038PS 5 - 7 MS/MSD 04-038PS 10 - 12	6.5 7.6 5.9
04-010PS 3 - 5 FD 04-010PS 5 - 7 04-010PS 8 - 10	7.7 4.5 7.3	04-025PS 1 - 3 04-025PS 3 - 5 FD 04-025PS 10 - 12	18 11 7.9	WDNR Cleanup Guideline (Industrial)	500

IRP – Installation Restoration Program.
BLS – Below land surface.
mg/kg – Milligrams per kilogram.
FD – Field Duplicate.
MS/MSD – Matrix Spike/Matrix Spike Duplicate.
PS – Push-Sample.
PZ – Piezometer.

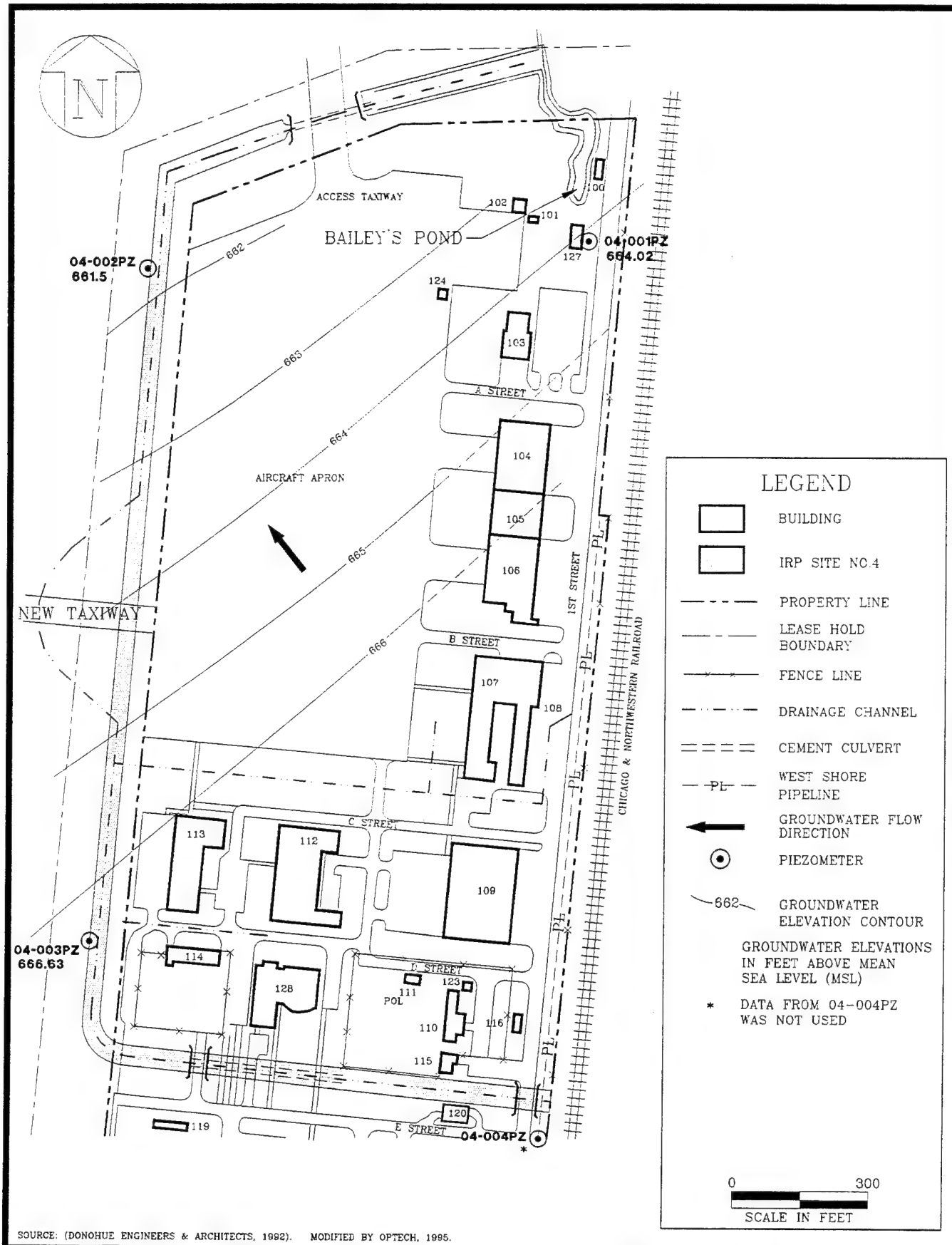
5.2.3.4 Groundwater Conditions

Groundwater depths observed while logging the push-sample borings and push-sample piezometers ranged from 2.5 to 12.0 feet BLS. The shallow groundwater was observed in push-borings around Bailey's Pond at depths of 2.5 to 6.0 feet BLS. Groundwater was observed in push-sample locations across the base at depths ranging from 7.0 to 12.0 feet BLS.

Four push-piezometers (04-001PZ - 04-004PZ) were installed on 28 and 31 October 1994. Push-piezometers 04-001PZ and 04-002PZ were pushed to a depth of 12.0 feet BLS. These push-piezometers were screened from 7.0 - 12.0 feet BLS. Push-piezometer 04-003PZ was pushed to a depth of 16.0 feet BLS and the screen set from 11.0 - 16.0 feet BLS. Push-piezometer 04-004PZ was pushed to a depth of 10.0 feet BLS and the screen set from 5.0 - 10.0 feet BLS. Water levels in the push-piezometers rose to levels ranging from 4.03 to 8.09 feet BLS, indicating possible semi-confined conditions. Boring logs show the lithology to be comprised of clay and silty clay overlying sandy clay, clayey sands, and sand. Boring logs are shown in Appendix D.

A potentiometric map of water levels in the push-piezometers is shown on Figure 5.13. Data from push-piezometer 04-004PZ was not used due to slow recharge (clay may have smeared on the screen slotting, resulting in lower water levels in 04-004PZ). Although groundwater directional flow data from the push-piezometers was generally in agreement with those data collected from the monitoring wells, differences in relative elevations exist. These differences might be caused by several factors, including the method of microwell construction and the screen length employed.

Monitoring well 04-001MW was drilled and installed on 4 November 1994, to a total depth of 19 feet BLS, with the screen set at 7.2 to 17.2 feet BLS. Monitoring well 04-002MW was drilled and installed on 7 November 1994, to a total depth of 20 feet BLS, with the screen set at 8.3 to 18.3 feet BLS. Monitoring well 04-003MW was drilled and installed on 7 November 1994, to a total depth of 19 feet BLS, with the screen set at 6.2 to 16.2 feet BLS. Monitoring well 04-004MW was drilled and installed on 4 November 1994, to a total depth of 19 feet BLS, with the screen set at 6.5 to 16.5 feet BLS. Monitoring well 04-005MW was drilled and installed on 7 November 1994, to a total depth of 20 feet BLS, with the screen set at 7.8 to 17.8 feet BLS. Complete well construction diagrams are presented in Appendix C.



SOURCE: (DONOHUE ENGINEERS & ARCHITECTS, 1992). MODIFIED BY OPTECH, 1995.

FIGURE 5.13

BILLYMIT\BM-BORE2

PIEZOMETER GROUNDWATER ELEVATIONS (MSL) 31 OCTOBER 1994

128th ARW, Gen. Billy Mitchell Field ANGB
Milwaukee, Wisconsin

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All five monitoring wells were developed using a bailer on 8 November 1994. The five monitoring wells were purged and sampled on 9 November 1994. All monitoring wells were again purged and sampled on 20 December 1994. Water level measurements were taken from all five monitoring wells just prior to sampling on 9 November 1994 and 20 December 1994 (see Table 5.7 and 5.8). The water level in monitoring well 04-005MW had not stabilized prior to the 9 November 1994 sampling event due to slow recharging of the well. As a result, the water level data for this well was not used to contour the water table. Figures 5.14 and 5.15 show the potentiometric surface determined using the measurements from the sampling events. Groundwater flow direction is toward the northwest with a hydraulic gradient ranging from 0.0033 to 0.0041 feet per foot. Temperature, pH, and specific conductance were measured for each groundwater sample and are listed by sampling round in Tables 5.7 and 5.8.

Table 5.7
Temperature, pH, Specific Conductance, Water Level Measurements, and Elevations for Groundwater Samples Collected from IRP Site No. 4 Monitoring Wells During the 9 November 1994 Groundwater Sampling 128th ARW, General Billy Mitchell Field ANGB, Milwaukee, Wisconsin

Monitoring Well	Temperature (° F)	pH	Specific Conductance (mmhos)	Depth to Water (feet BLS)	Water Table Elevation (MSL)
04-001MW	54.7	7.07	1,143	7.01	668.16
04-002MW	53.5	7.06	1,335	8.14	664.09
04-003MW	52.3	7.09	1,268	5.66	667.98
04-004MW	54.0	7.06	4,436	7.52	668.44
04-005MW	53.2	7.42	903	**	**

MSL – Mean Sea Level.
MW – Monitoring well.
° F – degrees Fahrenheit.
mmhos – millimhos.
BLS – Below Land Surface.
** – Monitoring well not stabilizing.

Although sampling protocols were strictly adhered to, instrument malfunction was experienced during the second round of groundwater sampling, and pH and specific conductance measurements may not be valid.

Four rising head slug tests were performed on four monitoring wells on 11 November 1994. The hydraulic conductivity of the shallow water-bearing zone at the site was estimated by conducting rising head slug tests in all monitoring wells except 04-003MW, due to its high level of contamination. Each test was performed by placing a solid acylic "slug" into the well to displace a known volume of groundwater. After displaced groundwater levels restablized within

Table 5.8
Temperature, pH, Specific Conductance, Water Level Measurements, and Elevations for Groundwater Samples Collected from IRP Site No. 4 Monitoring Wells During the 20 December 1994 Groundwater Sampling 128th ARW, General Billy Mitchell Field ANGB, Milwaukee, Wisconsin

Monitoring Well	Temperature (° F)	pH	Specific Conductance (mmhos)	Depth to Water (feet BLS)	Water Table Elevation (MSL)
04-001MW	50.5	6.61	201	6.24	668.93
04-002MW	50.7	6.40	193	7.42	664.81
04-003MW	51.2	6.10	179	5.78	667.86
04-004MW	51.6	*	202	7.21	668.75
04-005MW	51.9	*	160	5.92	670.28

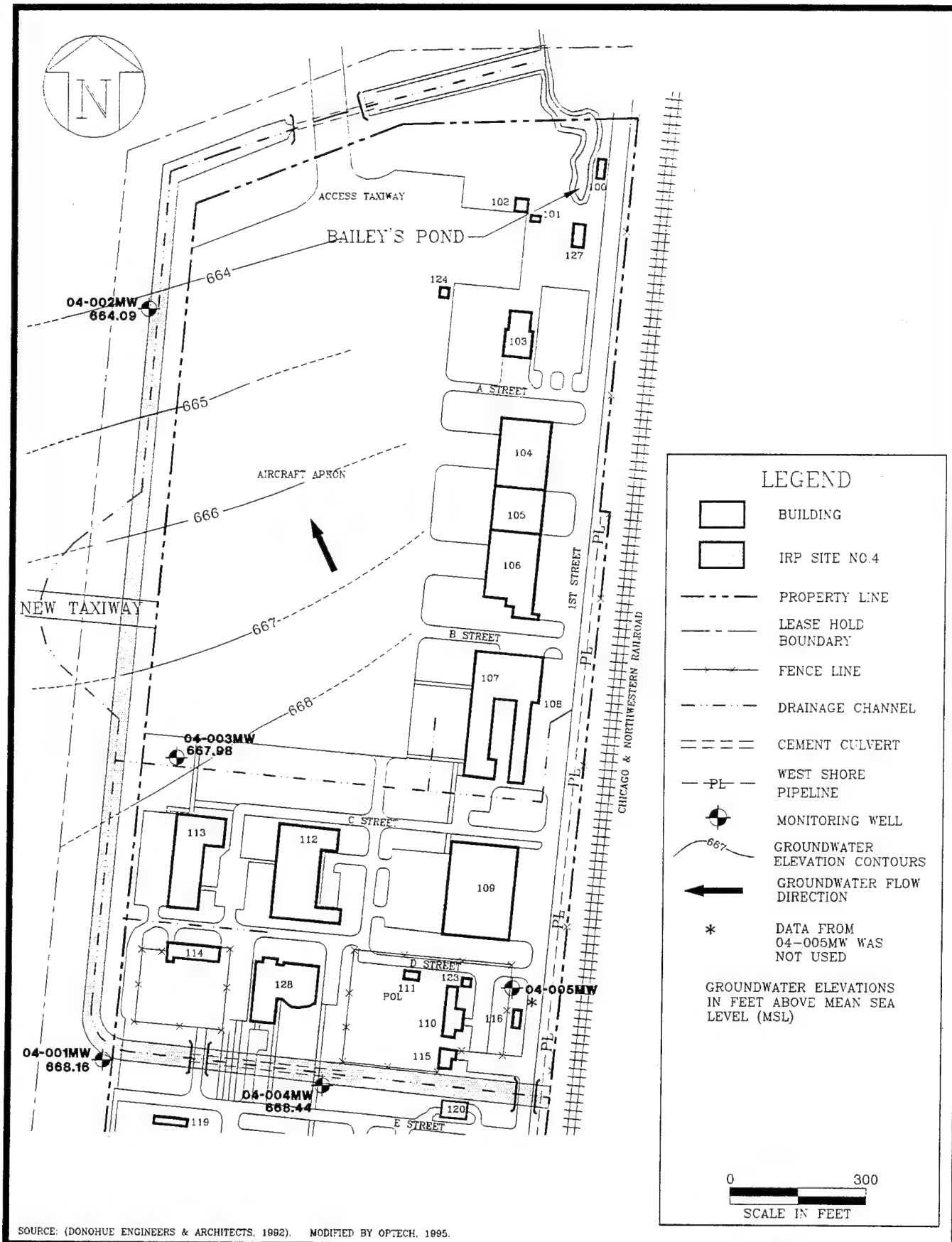
MSL – Mean Sea Level. MW – Monitoring well. BLS – Below Land Surface.
04 – Site No. 4. ° F – degrees Fahrenheit. mmhos – millimhos.
* – pH meter failure precluded the collection of reliable pH data.

the well the slug was retrieved rapidly from the monitoring well and the rate of the respondent water level rise within the well was recorded by measuring water pressure transients using a transducer interfaced with an automatic data logger. Specific details regarding the field methods and raw data outputs are provided in Appendix E.

Slug test data was analyzed by the Bouwer and Rice Method (Bouwer and Rice, 1976) as presented in Geraghty & Miller, Inc.'s "AQTESOLV" Version 2.0 computer program. The method is applicable to determining values of hydraulic conductivity in unconfined aquifers. The solution equation for the method along with a description of the solution elements and critical assumptions is provided in Appendix E. A summary of the results from the tests is presented in Table 5.9. The slug test data and analyses are presented in Appendix E. Due to variations in time-drawdowns data recorded from monitoring well 04-005MW, the results of this slug test are not considered valid.

Average groundwater flow velocities were calculated using the horizontal hydraulic conductivities calculated from slug data. The velocities range in value from 15.07 feet per year to 272.45 feet per year. The velocities were computed from the equation:

$$V=.134\frac{KI}{n}$$



SOURCE: (DONOHUE ENGINEERS & ARCHITECTS, 1992). MODIFIED BY OPTECH, 1995.

FIGURE 5.14

BILLYMIT\BM-BORE2

MONITORING WELL GROUNDWATER ELEVATIONS (MSL) 9 NOVEMBER 1994

128th ARW, Gen. Billy Mitchell Field ANGB
Milwaukee, Wisconsin

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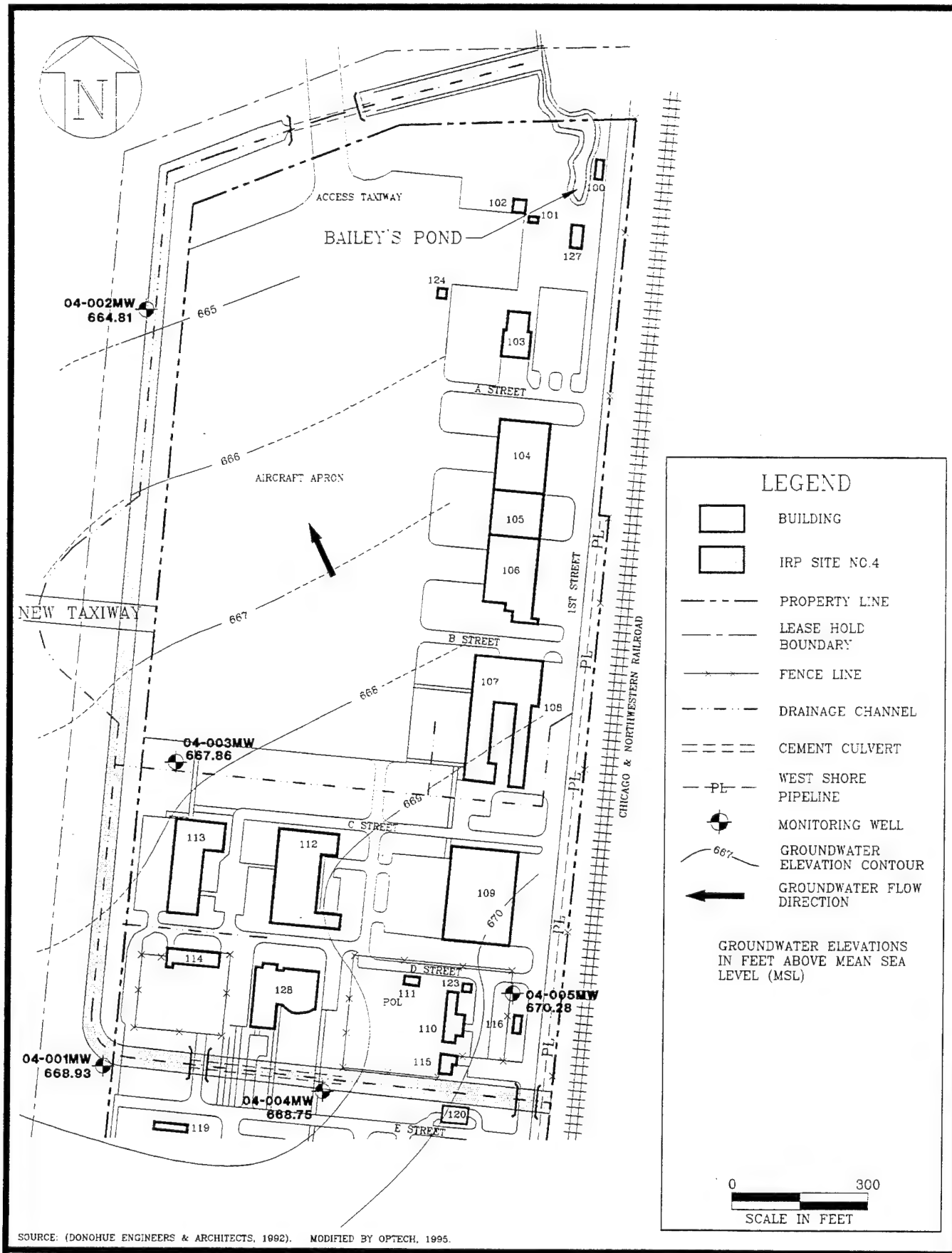

SOURCE: (DONOHUE ENGINEERS & ARCHITECTS, 1992). MODIFIED BY OPTECH, 1995.

FIGURE 5.15

BILLYMIT\BM-BORE2

MONITORING WELL GROUNDWATER ELEVATIONS (MSL) 20 DECEMBER 1994

128th ARW, Gen. Billy Mitchell Field ANGB
Milwaukee, Wisconsin

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Table 5.9
Summary of Slug Test Results
128 AFB, General Billy Mitchell Field ANGB, Milwaukee, Wisconsin

Monitoring Well Number	Horizontal Hydraulic Conductivity ($gal/day/ft^2$)	Horizontal Hydraulic Conductivity (cm/sec)
04-001MW	16.65	7.85×10^{-6}
04-002MW	61.73	2.91×10^{-5}
04-004MW	301.11	1.42×10^{-4}
04-005MW	- [1]	- [1]

[1]Hydraulic conductivity value was considered invalid due to erratic data.
$gal/day/ft^2$ – Gallons per day per $foot^2$.
cm/sec – Centimeter per second.

Where:

V = velocity, in feet per day;
K = horizontal hydraulic conductivity, in gpd/ft^2;
I = average hydraulic gradient, in feet per foot; and
n = aquifer net effective porosity, no dimensions.

The following values were used:

K = 16.65, 61.73, and 301.11 $gal/day/ft^2$, based on the aquifer slug tests (see Appendix E);
I = 0.0037 as measured from Figures 5.12 and 5.13; and
n = 0.20.

5.2.3.5 Nature and Extent of Groundwater Contamination

Collection of groundwater samples occurred in two phases, namely an initial phase of collecting groundwater screening samples from push-sample soil locations and piezometers, followed by a second phase of collecting groundwater confirmation samples from monitoring wells.

During the initial phase, eight groundwater screening samples were collected from the push-sample soil locations and four groundwater screening samples were collected from the push-sample piezometers during the period of 20 October 1994 to 3 November 1994. Subsequently, two rounds of groundwater samples were collected from the five monitoring wells

as part of this SI. The first round of monitoring well samples was collected on 8 and 9 November 1994 and the second round of samples was collected on 20 December 1994. Samples submitted for screening analyses are listed in Table 5.10, while samples submitted for confirmation analyses are listed in Table 5.11. A complete listing of laboratory results for all analyses is given in Appendix G.

Table 5.10
Groundwater Screening Sampling and Analytical Program for IRP Site No. 4
128th ARW, General Billy Mitchell Field ANGB, Milwaukee, Wisconsin

Borehole Number	Groundwater Analyses and Methods				
	VOCs (SW8020)	PAH (SW8310)	WDNR GRO	WDNR DRO	Lead (EPA239.2)
04-001PS	X	X	X	X	X
04-002PS	X	X	X	X	X
04-003PS	X	X	X	X	X
04-005PS	X	X	X	X	X
04-006PS	X	X	X	X	X
04-007PS	X	X	X	X	X
04-008PS	X	NS	X	X	NS
04-009PS	X	X	X	X	X
04-001PZ	X	X	X	X	X
04-002PZ	X	X	X	X	X
04-003PZ	X	NS	X	NS	NS
04-004PZ*	X	X	X	X	X

IRP – Installation Restoration Program.
VOCs – Volatile Organic Compounds.
PAH – Polynuclear Aromatic Hydrocarbons.
WDNR GRO – Wisconsin Department of Natural Resources Gasoline Range Organics.
WDNR DRO – Wisconsin Department of Natural Resources Diesel Range Organics.
EPA – Environmental Protection Agency.
PS – Push-Sample.
PZ – Piezometer.
NS – Insufficient groundwater recovery for analysis of this parameter.
* – QA/QC samples consisting of three equipment blanks and one trip blank were collected from this piezometer.

Holding times were exceeded for VOC analysis for two groundwater samples in the second round of sampling. VOC/GRO, DRO, and PAH surrogate recoveries were within acceptable limits except for 04-003MW and 04-004MW water samples from the second round of groundwater sampling. Surrogates for these two samples were outside QC limits due to dilutions performed to establish QC criteria. All spike recoveries and relative percent difference values were within acceptable limits.

Table 5.11
Groundwater Confirmation Sampling and Analytical Program for IRP Site No. 4
128th ARW, General Billy Mitchell Field ANGB, Milwaukee, Wisconsin

Borehole Number	Additional Samples	Sampling Round	Groundwater Analyses and Methods				
			VOCs (SW8020)	PAH (SW8310)	WDNR GRO	WDNR DRO	Lead (EPA239.2)
04-001MW		First	X	X	X	X	X
04-002MW		First	X	X	X	X	X
04-003MW		First	X	X	X	X	X
	FD	First	X	X	X	X	X
04-004MW		First	X	X	X	X	X
04-005MW		First	X	X	X	X	X
	Equipment Blanks (1)	First	X	X	X	X	X
	Trip Blanks (2)	First	X				
04-001MW		Second	X	X	X	X	X
	FD	Second	X	X	X	X	X
04-002MW		Second	X	X	X	X	X
04-003MW		Second	X	X	X	X	X
04-004MW		Second	X	X	X	X	X
04-005MW		Second	X	X	X	X	X
	Equipment Blanks (1)	Second	X	X	X	X	X
	Field Blanks (1)	Second	X	X	X	X	X
	Trip Blanks (2)	Second	X				

IRP – Installation Restoration Program.
VOCs – Volatile Organic Compounds.
PAH – Polynuclear Aromatic Hydrocarbons.
WDNR GRO – Wisconsin Department of Natural Resources Gasoline Range Organics.
WDNR DRO – Wisconsin Department of Natural Resources Diesel Range Organics.
EPA – Environmental Protection Agency.
MW – Monitoring Well.
FD – Field Duplicate.

5.2.3.5.1 DRO and GRO Contamination

No WDNR cleanup guidelines exist for DRO or GRO in groundwater; however, if these analytes are detected, further monitoring of groundwater for indicator compounds such as benzene, toluene, ethylbenzene, and xylenes is required.

5.2.3.5.1.1 Screening Results

DRO detected in groundwater screening samples are shown in Table 5.12. DRO were detected only at concentrations of 0.21 and 0.13 milligrams per liter (mg/L) in samples 04-005PS and 04-008PS, respectively. DRO contamination in groundwater screening samples is shown in Figure 5.16.

GRO detected in groundwater screening samples are shown in Table 5.12. The highest concentration of GRO, 55,000 micrograms per liter (μg/L), was detected in sample 04-003PZ. GRO was also detected at lower levels in samples 04-002PZ, 04-001PS, and 04-005PS. GRO contamination in groundwater screening samples is shown in Figure 5.17.

5.2.3.5.1.2 Confirmation Results

DRO detected in groundwater confirmation samples are shown in Table 5.13. DRO were detected in six groundwater samples at concentrations ranging from 0.10 to 60 mg/L, with the highest concentration detected in sample 04-003MW. Figure 5.18 shows DRO concentrations in groundwater for the two sampling rounds.

GRO detected in groundwater confirmation samples are shown in Table 5.13. GRO were detected in three groundwater samples at concentrations ranging from 74,000 to 100,000 μg/L, with the highest concentration detected in sample 04-003MW. Figure 5.19 shows GRO concentrations in groundwater for the two sampling rounds.

5.2.3.5.2 VOC Contamination

5.2.3.5.2.1 Screening Results

VOCs detected in groundwater screening samples are shown in Table 5.14. VOC compounds were detected ranging from 0.7 to 3,900 μg/L for benzene, from 2.5 to 12,000 μg/L for toluene, from 1.3 to 3,400 μg/L for ethylbenzene, from 4.8 to 20,000 μg/L for total xylenes, from 1.4

Table 5.12
Diesel and Gasoline Range Organics Detected in Groundwater Screening Samples Collected at IRP Site No. 4 128th ARW, General Billy Mitchell Field ANGB, Milwaukee, Wisconsin

Sample Location	Analyte	
	Diesel Range Organics (mg/L)	Gasoline Range Organics (μg/L)
04-002PZ	0.1U	240
04-003PZ	–	55,000
04-001PS	0.1U	120
04-005PS	0.21	280
04-008PS	0.13 D3	50U

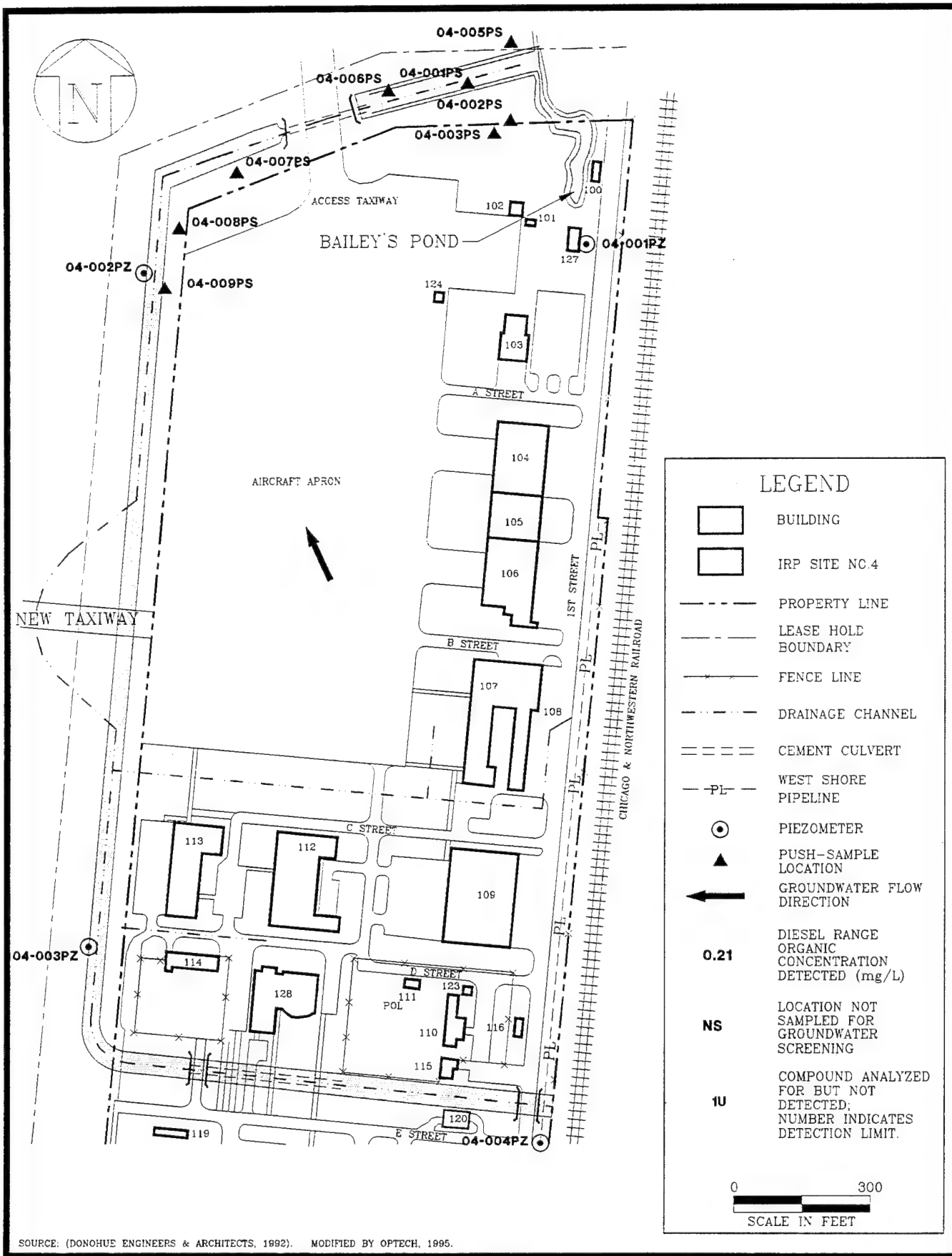
IRP – Installation Restoration Program.
mg/L – milligrams per liter.
PZ – Piezometer.
PS – Push-Sample.
U – Compound analyzed for but not detected. Number indicates the detection limit.
μg/L – micrograms per liter.
LB – Low boiling point components are present in sample.
"–" – Compound not analyzed.
D3 – Possible laboratory phthalate contaminant, not part of the hydrocarbon pattern associated with this method, was found in the sample. The observed value was subtracted from the report.

Table 5.13
Diesel and Gasoline Range Organics Detected in Groundwater Confirmation Samples Collected at IRP Site No. 4 128th ARW, General Billy Mitchell Field ANGB, Milwaukee, Wisconsin

Sample Location	Sampling Round	Analyte	
		Diesel Range Organics (mg/L)	Gasoline Range Organics (μg/L)
04-003MW	First	53LB	78,000
04-003MW FD	First	48LB	74,000
04-005MW	First	1.4	50U
04-002MW	Second	0.13	50U
04-003MW	Second	60LB	100,000
04-004MW	Second	0.10	50U

IRP – Installation Restoration Program.
mg/L – milligrams per liter.
MW – Monitoring Well.
FD – Field Duplicate.
First Round – 8 & 9 November 1994.
LB – Low boiling point components are present in sample.
U – Compound analyzed for but not detected. Number indicates the detection limit.
μg/L – micrograms per liter.
Second Round – 20 December 1994.

to 860 μg/L for 1,3,5-trimethylbenzene, and from 3.7 to 2,600 μg/L for 1,2,4-trimethylbenzene. The highest concentrations of VOCs were detected in sample 04-003PZ. Benzene concentrations in groundwater screening samples are shown in Figure 5.20.



SOURCE: (DONOHUE ENGINEERS & ARCHITECTS, 1992). MODIFIED BY OPTECH, 1995.

FIGURE 5.16

DIESEL RANGE ORGANICS DETECTED IN GROUNDWATER SCREENING SAMPLES

128th ARW, Gen. Billy Mitchell Field ANGB
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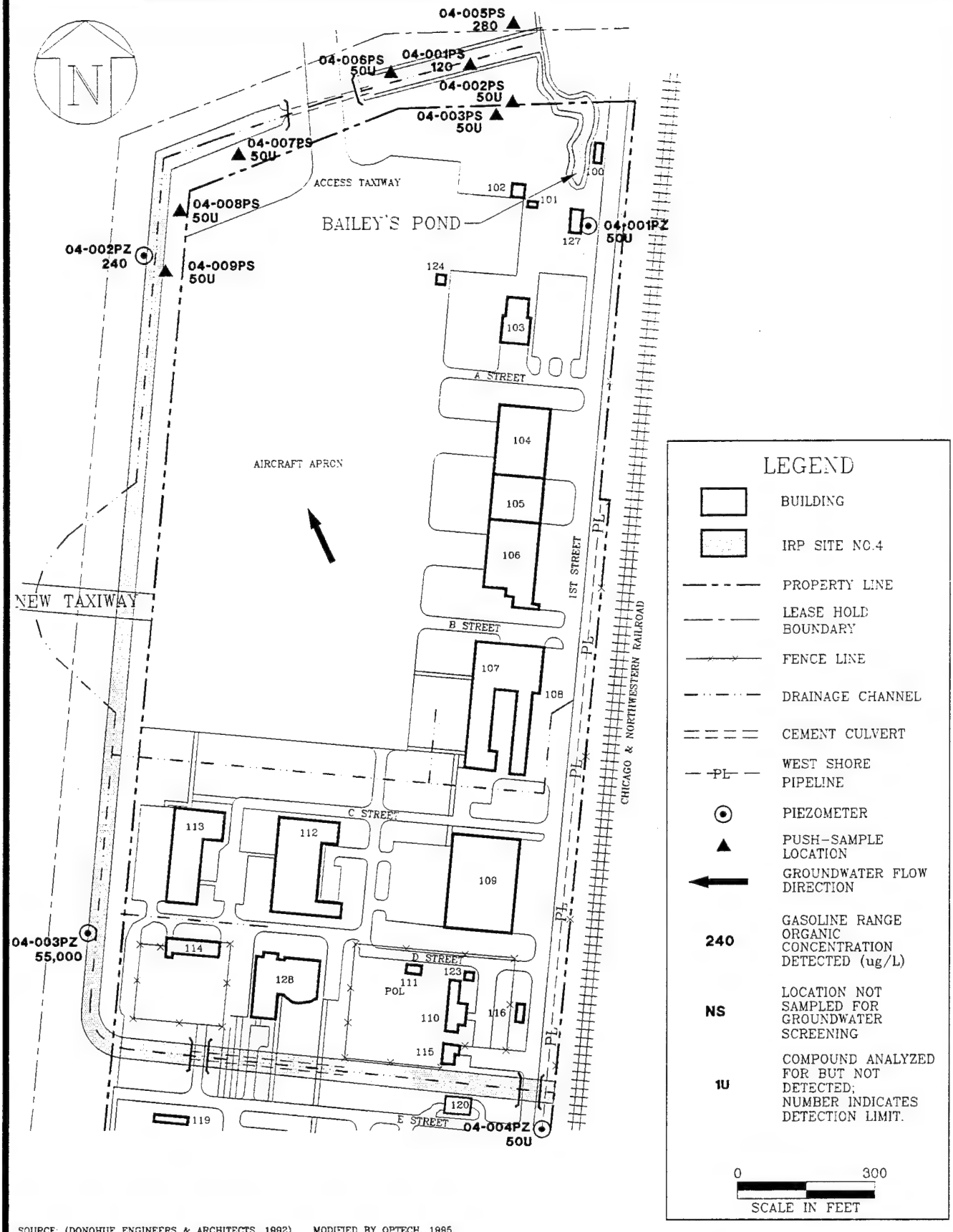

SOURCE: (DONOHUE ENGINEERS & ARCHITECTS, 1992). MODIFIED BY OPTECH, 1995.

FIGURE 5.17

GASOLINE RANGE ORGANICS DETECTED IN GROUNDWATER SCREENING SAMPLES

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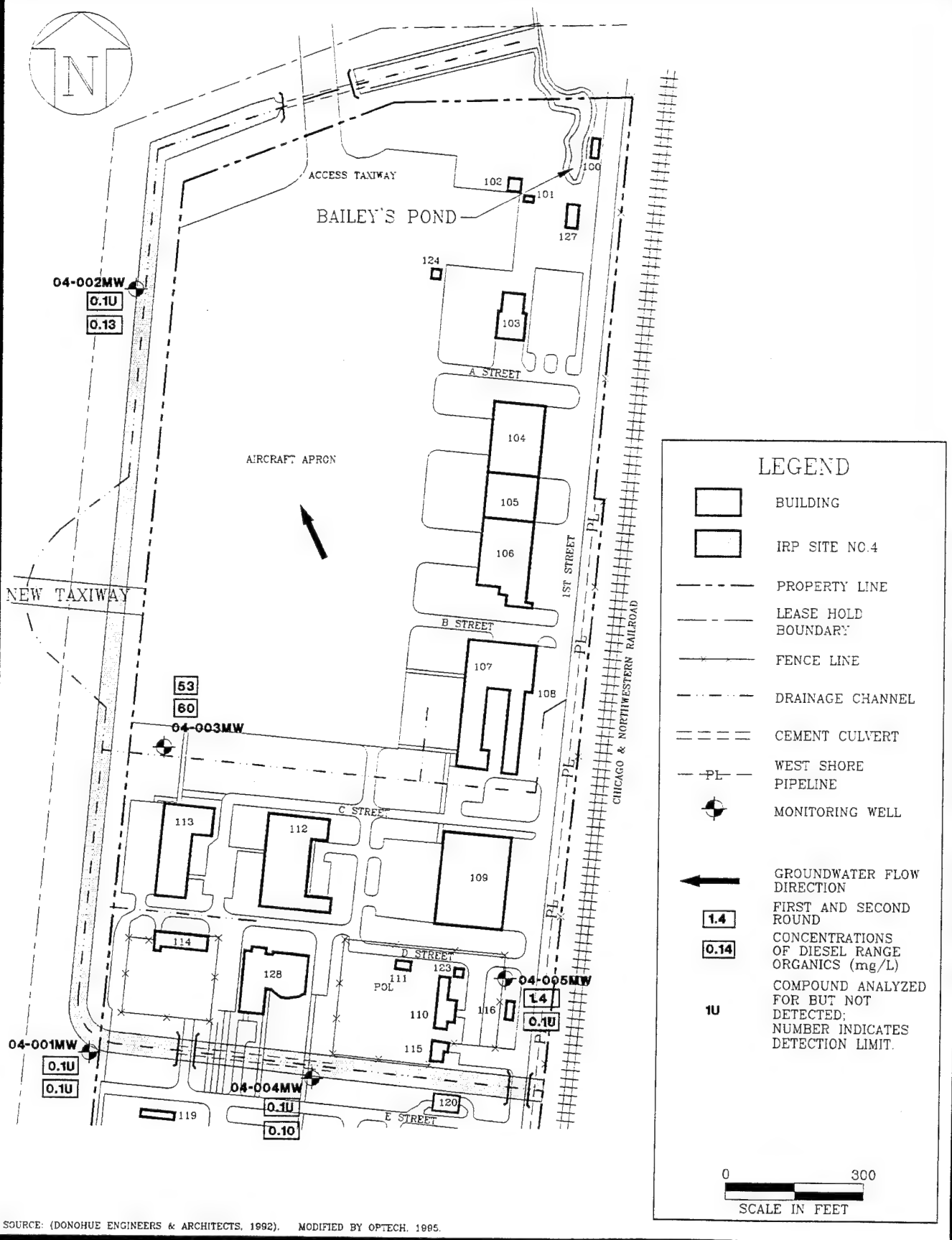

SOURCE: (DONOHUE ENGINEERS & ARCHITECTS, 1992). MODIFIED BY OPTECH, 1995.

FIGURE 5.18

BILLYMIT\BM-BORE2

DIESEL RANGE ORGANICS DETECTED IN GROUNDWATER SAMPLES

128th ARW, Gen. Billy Mitchell Field ANGB
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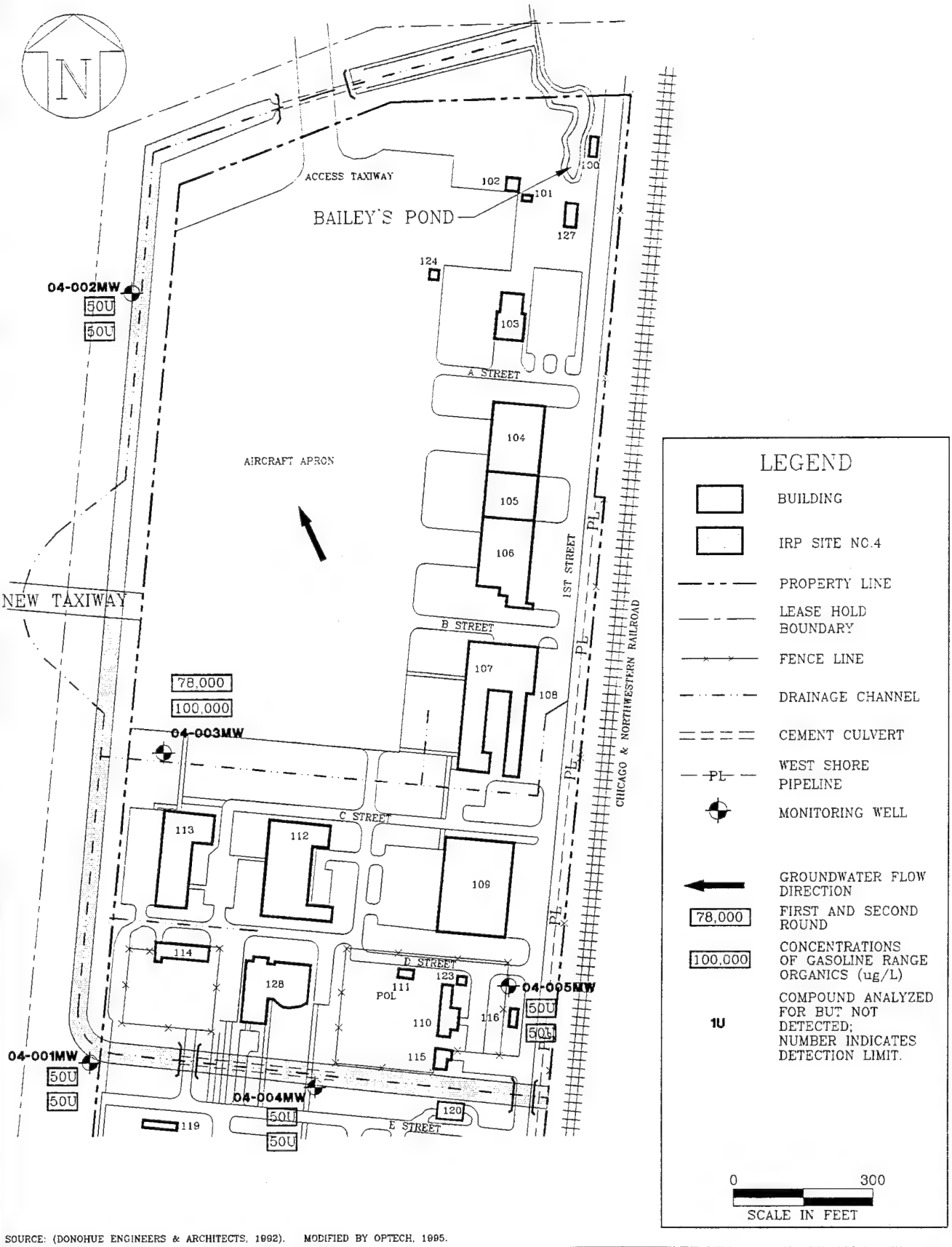

SOURCE: (DONOHUE ENGINEERS & ARCHITECTS, 1992). MODIFIED BY OPTECH, 1995.

FIGURE 5.19

BILLYMIT\BM-BORE2

GASOLINE RANGE ORGANICS DETECTED IN GROUNDWATER SAMPLES

128th ARW, Gen. Billy Mitchell Field ANGB
Milwaukee, Wisconsin

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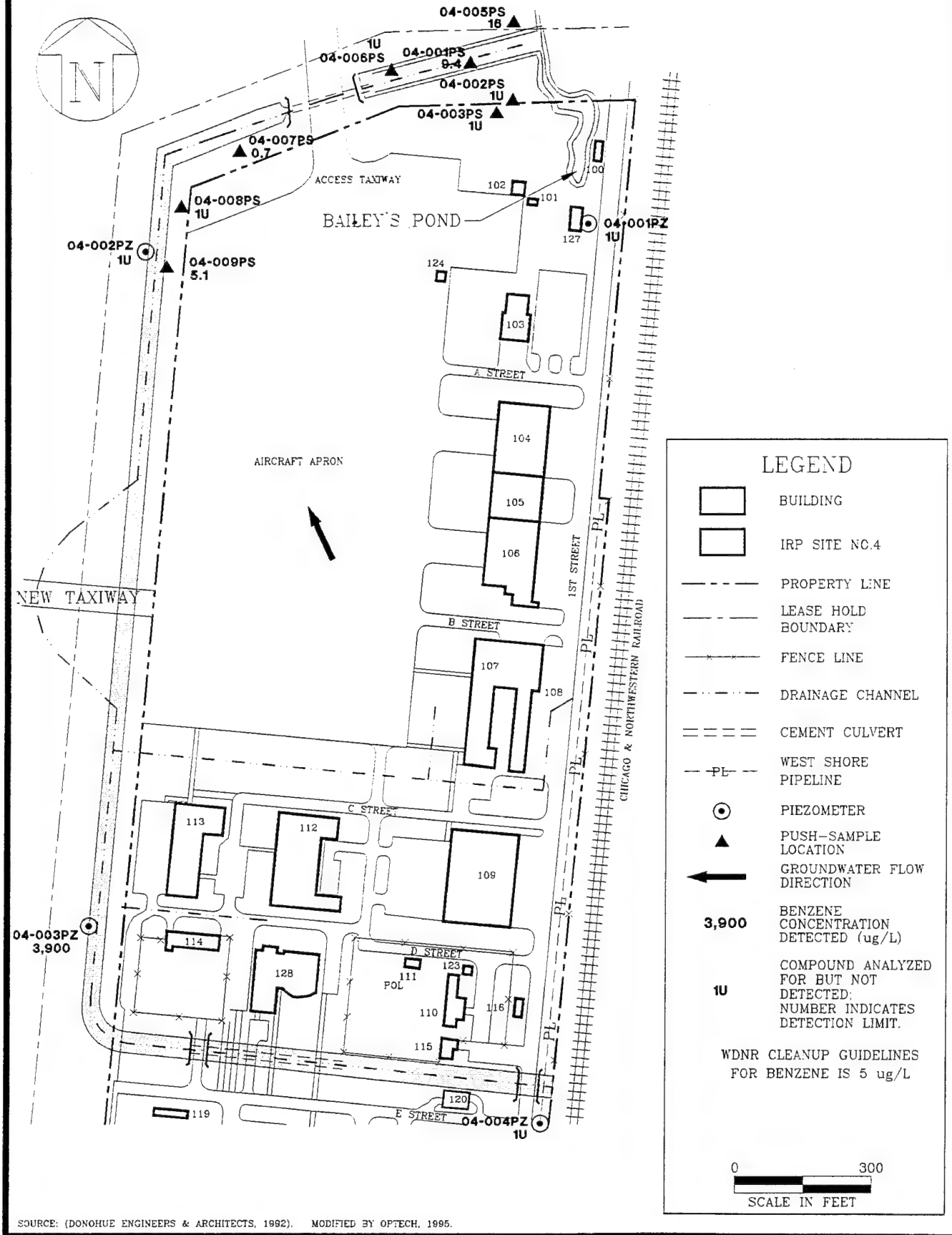

SOURCE: (DONOHUE ENGINEERS & ARCHITECTS, 1992). MODIFIED BY OPTECH, 1995.

FIGURE 5.20

BILLYMIT\BM-BORE2

BENZENE DETECTED IN GROUNDWATER SCREENING SAMPLES

128th ARW, Gen. Billy Mitchell Field ANGB
Milwaukee, Wisconsin

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Table 5.14
Volatile Organic Compounds Detected
in Groundwater Screening Samples Collected at IRP Site No. 4
128th ARW, General Billy Mitchell Field ANGB, Milwaukee, Wisconsin

Sample Location	VOCs (μg/L)					
	Benzene	Toluene	Ethylbenzene	Total Xylenes	1,3,5-Trimethyl-benzene	1,2,4-Trimethyl-benzene
04-002PZ	1U	260	1.3	1U	1U	1U
04-003PZ	**3,900**	**12,000**	**3,400**	**20,000**	860	2.600
04-001PS	**9.4**	1U	8.2	4.8	1.4	21
04-005PS	**16**	2.5	2.8	16	21	34
04-007PS	0.7J	1U	1.3U	1U	1U	1U
04-009PS	**5.1**	4.9	4.2	14	4.5	3.7
WDNR Cleanup Guidelines	5	343	700	620	NA	NA

VOCs – Volatile Organic Compounds.
IRP – Installation Restoration Program.
μg/L – micrograms per liter.
PZ – Piezometer.
PS – Push-Sample.
PQL – Practical Quantitation Limit.
Bold values exceed WDNR cleanup guidelines.
U – Compound analyzed for but not detected. Number indicates the detection limit.
J – Detected below PQL; therefore, result is an estimated concentration.
WDNR – Wisconsin Department of Natural Resources.
NA – Not Available.

5.2.3.5.2.2 Confirmation Results

Six VOCs detected in groundwater confirmation samples are shown in Table 5.15. VOC compounds were detected in eight groundwater samples at concentrations ranging from 0.7 to 7,200 μg/L for benzene, 1.0 to 32,000 μg/L for toluene, 3,300 to 4,400 μg/L for ethylbenzene, 17,000 to 21,000 μg/L for total xylenes, 950 to 1,200 μg/L for 1,3,5-trimethylbenzene, and 2,200 to 3,100 μg/L for 1,2,4-trimethylbenzene, with the highest concentration detected in sample 04-003MW. Figures 5.21 and 5.22 show benzene, toluene, ethylbenzene, and xylenes concentrations in groundwater samples for the first and second sampling rounds, respectively.

The high concentrations of VOCs detected in groundwater confirmation samples indicate there is a potential for continual contamination from the fuel components present in the soil.

5.2.3.5.3 PAH Contamination

5.2.3.5.3.1 Screening Results

PAH detected in groundwater screening samples are shown in Table 5.16. The PAH phenanthrene, anthracene, pyrene, benzo(b)fluoranthene, benzo(k)fluoranthrene, benzo(a)pyrene,

Table 5.15
Volatile Organic Compounds Detected
in Groundwater Confirmation Samples Collected at IRP Site No. 4
128th ARW, General Billy Mitchell Field ANGB, Milwaukee, Wisconsin

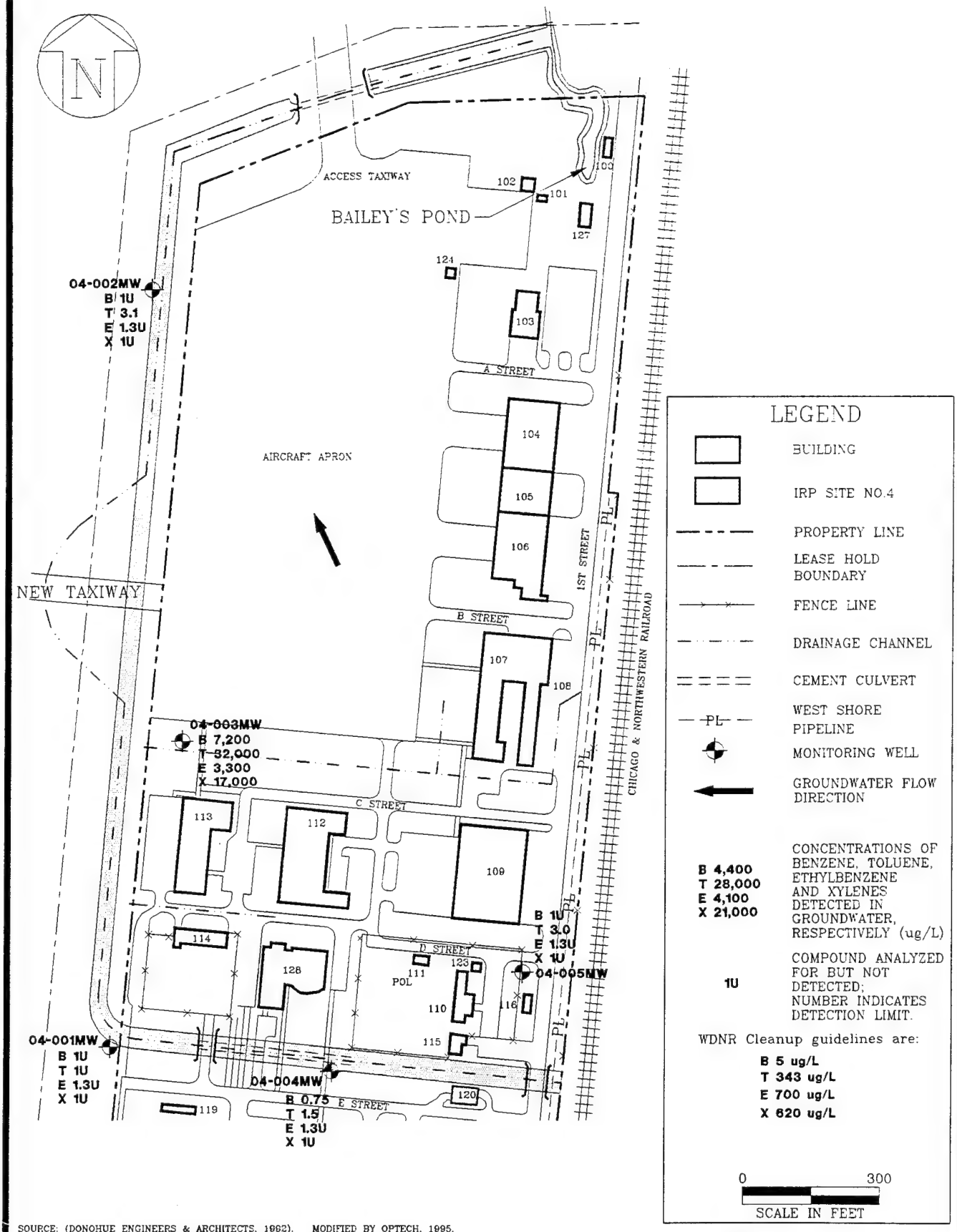
Sample Location	Sampling Round	VOCs (µg/L)					
		Benzene	Toluene	Ethyl-benzene	Total Xylenes	1,3,5-Trimethyl-benzene	1,2,4-Trimethyl-benzene
04-002MW	First	1U	3.1	1.3U	1U	1U	1U
04-003MW	First	**5,200**	**32,000**	**3,300**	**17,000**	980	2,200
04-003MW FD	First	**7,200**	**30,000**	**3,300**	**17,000**	950	2,400
04-004MW	First	0.7J	1.5	1.3U	1U	1U	1U
04-005MW	First	1U	3.0	1.3U	1U	1U	1U
04-003MW	Second	**4,400**	**28,000**	**4,100**	**21,000**	1,200	3,100
04-004MW	Second	1U	1.0	1.3U	1U	1U	1U
04-005MW	Second	1U	1.5	1.3U	1U	1U	1U
WDNR Cleanup Guidelines		5	343	700	620	NA	NA

VOCs – Volatile Organic Compounds.
IRP – Installation Restoration Program.
µg/L – micrograms per liter.
MW – Monitoring Well.
FD – Field Duplicate.
U – Compound analyzed for but not detected. Number indicates the detection limit.
First Round – 8 & 9 November 1994.
PQL – Practical Quantitation Limit.
J – Detected below PQL; therefore, result is an estimated concentration.
WDNR – Wisconsin Department of Natural Resources.
NA – Not Available.
Second Round – 20 December 1994.
Bold values exceed WDNR cleanup guidelines.

benzo(ghi)perylene, and indeno(1,2,3-cd)pyrene were detected only in sample 04-004PZ at concentrations of 3.88, 1.05, 5.06, 3.73, 1.57, 3.02, 1.72, and 0.84 µg/L, respectively. The PAH fluoranthene, benzo(a)anthracene, and chrysene were detected at concentrations ranging from 4.47 to 8.05 µg/L, 0.14 to 3.16 µg/L, and 0.63 to 2.36 µg/L, respectively, with the highest concentrations detected in sample 04-004PZ. Only benzo(a)pyrene exceeds the WDNR cleanup guideline of 0.003 µg/L.

5.2.3.5.3.2 Confirmation Results

PAH detected in groundwater confirmation samples are shown in Table 5.17. The PAH naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene were detected only in sample 04-003MW (first round) at concentrations of 518.3, 97.95, and 421.5 µg/L, respectively. The PAH pyrene, benzo(a)anthracene, and chrysene were detected only in sample 04-003MW (second round) at concentrations of 0.36, 0.63, and 0.50 µg/L, respectively. Only naphthalene exceeds the WDNR cleanup guideline of 40 µg/L.



SOURCE: (DONOHUE ENGINEERS & ARCHITECTS, 1992). MODIFIED BY OPTECH, 1995.

FIGURE 5.21

BILLYMIT\BM-BORE

BENZENE, TOLUENE, ETHYLBENZENE, AND XYLENES DETECTED IN GROUNDWATER (FIRST ROUND SAMPLING)
128th ARW, Gen. Billy Mitchell Field ANGB
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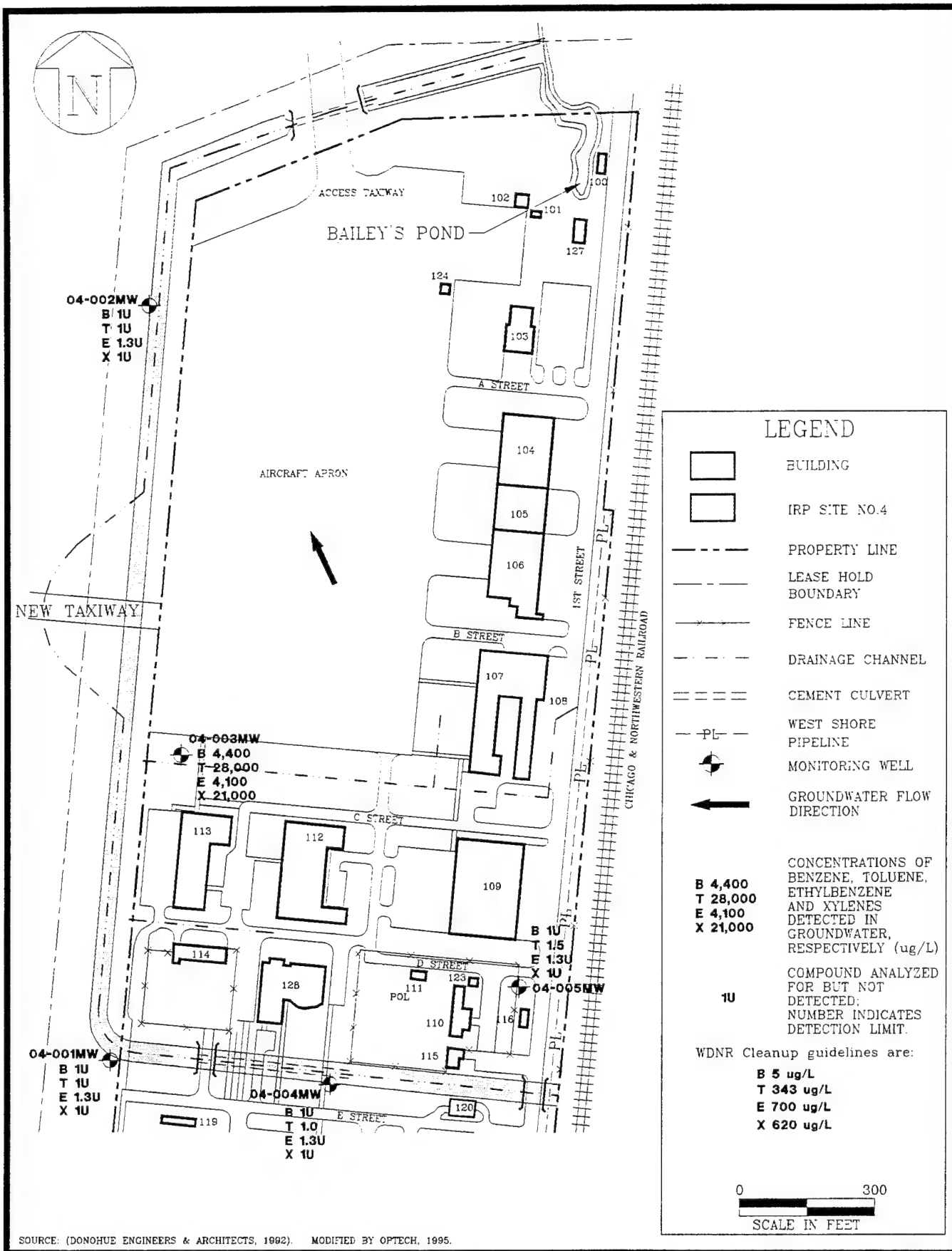

SOURCE: (DONOHUE ENGINEERS & ARCHITECTS, 1992). MODIFIED BY OPTECH, 1995.

FIGURE 5.22

BILLYMIT\BM-BORE

BENZENE, TOLUENE, ETHYLBENZENE, AND XYLENES DETECTED IN GROUND-WATER (SECOND ROUND SAMPLING)
128th ARW, Gen. Billy Mitchell Field ANGB
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Table 5.16
Polynuclear Aromatic Hydrocarbons Detected in Groundwater Screening Samples Collected at IRP Site No. 4 128th ARW, General Billy Mitchell Field ANGB, Milwaukee, Wisconsin

PAH (µg/L)	Sample Location		WDNR Cleanup Guidelines
	04-004PZ	04-006PS	
Phenanthrene	3.88	.04U	NA
Anthracene	1.05	.01U	NA
Fluoranthene	8.05	4.47	NA
Pyrene	5.06	.01U	NA
Benzo(a)anthracene	3.16	0.14	NA
Chrysene	2.36	0.63	NA
Benzo(b)fluoranthene	3.73	.02U	NA
Benzo(k)fluoranthrene	1.57	.01U	NA
Benzo(a)pyrene	**3.02**	.01U	.003
Benzo(ghi)perylene	1.72	.01U	NA
Indeno(1,2,3-cd)pyrene	0.84	.01U	NA

PAH(s) – Polynuclear Aromatic Hydrocarbon(s).
IRP – Installation Restoration Program.
µg/L – micrograms per liter.
PZ – Piezometer.
Bold values exceed WDNR cleanup guidelines.
PS – Push-Sample.
U – Compound analyzed for but not detected. Number indicates the detection limit.
NA – Not Available.

Table 5.17
Polynuclear Aromatic Hydrocarbons Detected in Groundwater Confirmation Samples Collected at IRP Site No. 4 128th ARW, General Billy Mitchell Field ANGB, Milwaukee, Wisconsin

PAH (µg/L)	Sample Location		WDNR Cleanup Guidelines
	04-003MW FD (First Round)	04-003MW (Second Round)	
Naphthalene	**518.3**	.05U	40
Pyrene	.01U	0.36	NA
Benzo(a)anthracene	0.4U	0.63	NA
Chrysene	.03U	0.50	NA
1-Methyl Naphthalene	97.95	.04U	NA
2-Methyl Naphthalene	421.5	.07U	NA

PAH(s) – Polynuclear Aromatic Hydrocarbon(s).
IRP – Installation Restoration Program.
µg/L – micrograms per liter.
MW – Monitoring Well.
First Round – 8 & 9 November 1994.
Bold values exceed WDNR cleanup guidelines.
FD – Field Duplicate.
U – Compound analyzed for but not detected. Number indicates the detection limit.
NA – Not Available.
Second Round – 20 December 1994.

5.2.3.5.4 Lead Contamination

5.2.3.5.4.1 Screening Results

Lead detected in groundwater screening samples is shown in Table 5.18. The concentrations detected ranged from 5.5 to 290 μg/L, with the highest concentration detected in sample 04-002PZ.

Table 5.18
Lead Detected in Groundwater Screening Samples Collected at IRP Site No. 4
128th ARW, General Billy Mitchell Field ANGB, Milwaukee, Wisconsin

Sample Location	Lead (μg/L)
04-001PZ	**27**
04-002PZ	**290**
04-004PZ	**170**
04-001PS	**45**
04-002PS	9.6
04-006PS	**68**
04-007PS	5.5
WDNR Cleanup Guidelines	15

IRP – Installation Restoration Program.
μg/L – micrograms per liter.
PZ – Piezometer.
PS – Push-Sample.
U – Compound analyzed for but not detected. Number indicates the detection limit.
WDNR – Wisconsin Department of Natural Resources.
Bold values exceed WDNR cleanup guidelines.

Lead in samples from locations 04-001PZ, 04-002PZ, 04-004PZ, 04-001PS, and 04-006PS exceeds the WDNR cleanup guideline of 15 μg/L. Figure 5.23 shows the concentrations of lead detected in groundwater screening samples.

5.2.3.5.4.2 Confirmation Results

Lead was detected in groundwater confirmation samples as shown in Table 5.19. Lead was detected in 10 groundwater samples at concentrations ranging from 3.4 to 410 μg/L, with the highest concentration detected in sample 04-003MW. Lead concentrations exceeded WDNR cleanup guideline of 15 μg/L in all groundwater samples, with the exception of 04-002MW. Figure 5.24 shows the lead concentrations for the two sampling rounds.

Table 5.19
Lead Detected in Groundwater Confirmation Samples Collected at IRP Site No. 4
128th ARW, General Billy Mitchell Field ANGB, Milwaukee, Wisconsin

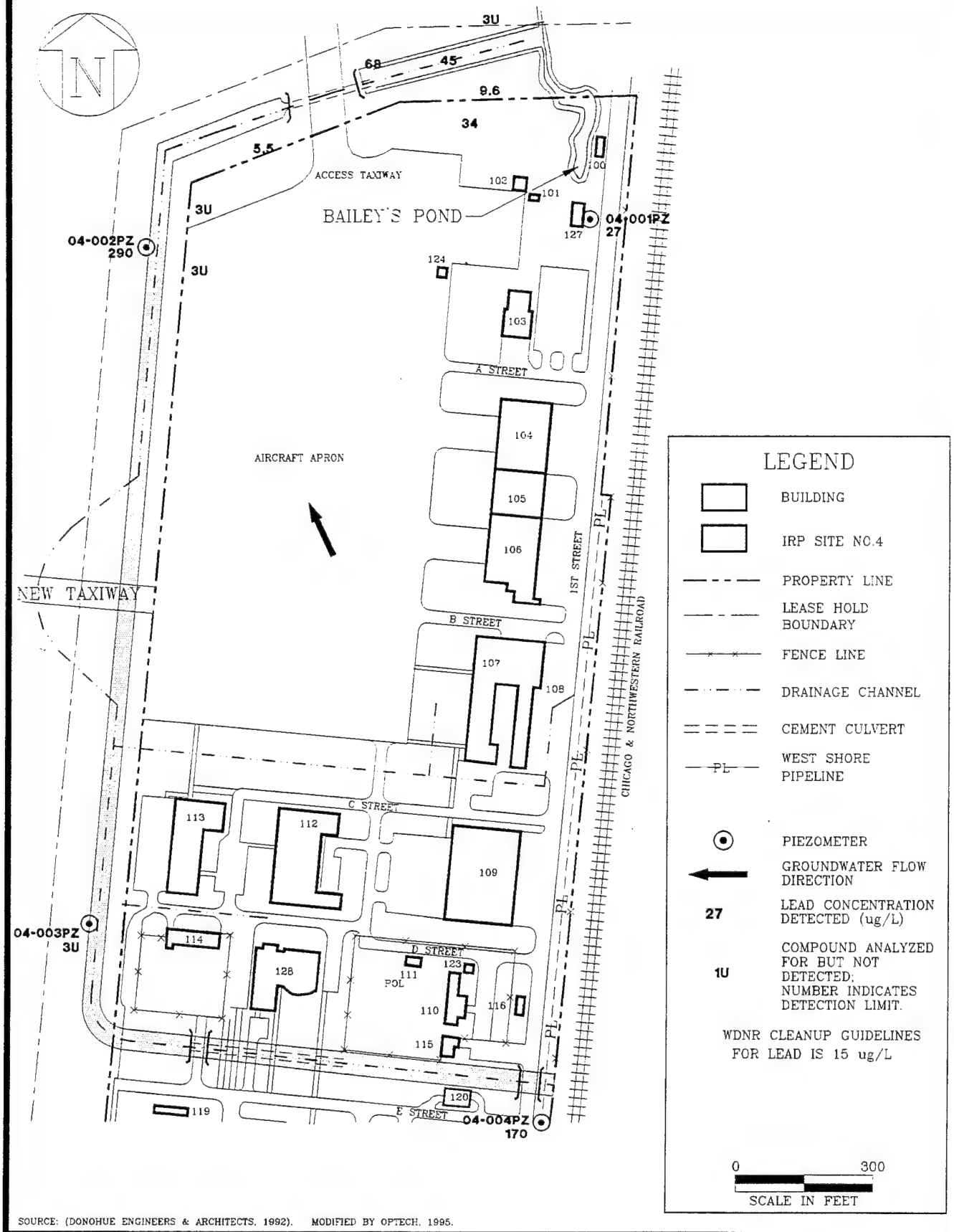
Sample Location	Sampling Round	Lead (µg/L)
04-001MW	First	**42**
04-002MW	First	6.8
04-003MW	First	**410**
04-003MW FD	First	**240**
04-004MW	First	**52**
04-005MW	First	**26**
04-002MW	Second	3.4
04-003MW	Second	**260**
04-004MW	Second	4.2
04-005MW	Second	13
WDNR Cleanup Guidelines		15

IRP – Installation Restoration Program.
µg/L – micrograms per liter.
MW – Monitoring Well.
First Round – 8 & 9 November 1994.
FD – Field Duplicate.
WDNR – Wisconsin Department of Natural Resources.
Second Round – 20 December 1994.
Bold Values exceed WDNR cleanup guidelines.

5.2.4 Conclusions

Soil and groundwater contamination above WDNR cleanup guidelines exists in various areas throughout the base. Generally, two areas of soil contamination occur, in the southern and southwest area of the drainage ditch, and at Bailey's Pond. Groundwater contamination exists primarily in the area of monitoring well 04-003MW and piezometer 04-003PZ, along the southwest part of the drainage ditch. These areas of contamination are consistent with the fuel migration pathway of the West Shore Pipeline release.

A previously suspected source of contamination near Building 114 near the southwest portion of the drainage ditch was two USTs used to store waste jet fuel. The USTs had failed tank tightness testing. However, upon removal of the USTs, analytical results of soil samples around the tanks indicated that the two tanks did not appear to be the source of contamination detected near Building 114.



SOURCE: (DONOHUE ENGINEERS & ARCHITECTS, 1992). MODIFIED BY OPTECH, 1995.

FIGURE 5.23

BILLYMIT\BM-BORE2

LEAD DETECTED IN GROUNDWATER SCREENING SAMPLES

128th ARW, Gen. Billy Mitchell Field ANGB
Milwaukee, Wisconsin

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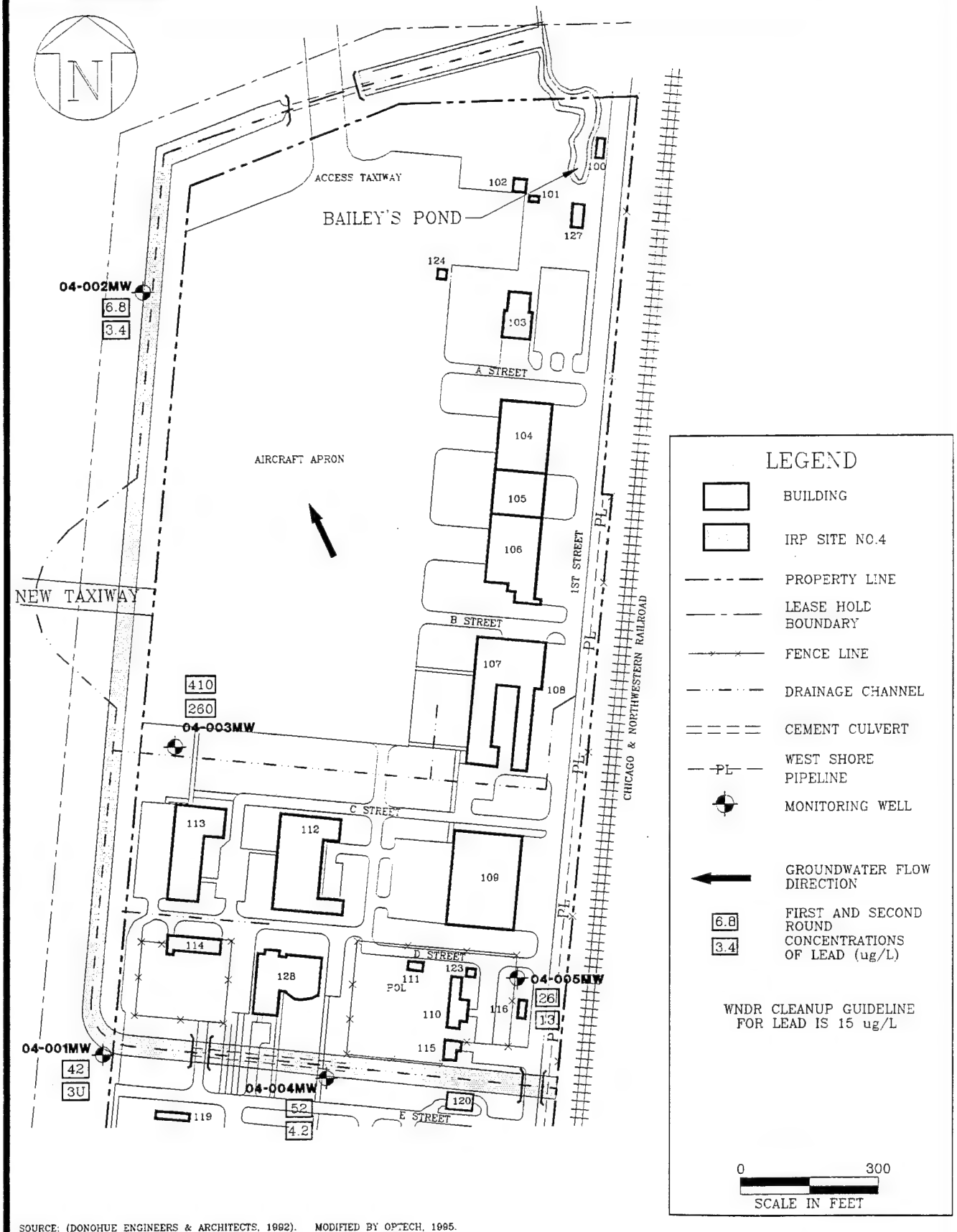

SOURCE: (DONOHUE ENGINEERS & ARCHITECTS, 1992). MODIFIED BY OPTECH, 1995.

FIGURE 5.24

BILLYMIT\BM-BORE2

LEAD DETECTED IN GROUNDWATER SAMPLES

128th ARW, Gen. Billy Mitchell Field ANGB
Milwaukee, Wisconsin

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Soil contamination (DRO) was detected at the groundwater protection standard of 100 mg/kg in one sample collected near Buildings 107 and 108, which is not adjacent to or in the vicinity of IRP Site No. 4. The source of this contamination is unknown.

In conformance with the Work Plan, no background sampling was conducted during the Site Investigation. However, in order to evaluate the extent of contamination resulting from the fuel spill, it will be necessary to collect background samples to establish background conditions at locations not in close proximity to IRP Site No. 4.

Soil and groundwater contamination have not been defined west of the western drainage ditch/base boundary, and further investigation is warranted in this area.

SECTION 6.0 CONCLUSIONS

6.1 SUMMARY

An WP was conducted for IRP Site No. 4 (Base Drainage Ditch) at the 128th ARW, Billy Mitchell Field ANGB, Milwaukee, Wisconsin. IRP Site No. 4 is the central drainage ditch at the base that channels stormwater runoff from the base and adjacent properties, terminating in Bailey's Pond and entry into the municipal stormwater system. The drainage ditch was originally identified during the Phase I Records Search and the Addendum Record Search conducted during the mid-1980s as an area of possible environmental concern. During August 1992 and Spring 1993, petroleum hydrocarbon-contaminated soil was encountered in the area of the drainage ditch while constructing a new taxiway from the aircraft parking apron to the runway. A possible source for the petroleum contamination was a 1968 commercial pipeline spill that occurred on the eastern border of the base. Up to 600,000 gallons of gasoline were released into the drainage ditch when the West Shore Pipeline ruptured.

HQ ANG/CEVR contracted OpTech to prepare an SI Work Plan and conduct an SI at IRP Site No. 4. The investigation was conducted as outlined in the SI Work Plan submitted to HQ ANG/CEVR in September 1994 and approved in October 1994. The field investigation was conducted between 17 October 1994 and 12 November 1994. On 20 December 1994, a second round of groundwater samples was collected from monitoring wells installed at the site.

The purpose of the SI was to confirm, through field activities, the presence or absence of contamination at IRP Site No. 4, to attempt to determine the areal extent of any contamination detected, and to provide data needed to reach a decision point for the site. The Site Investigation at the base was accomplished by completing the following tasks:

- Advancing 38 push-sample soil boring locations;
- Advancing four push-sample piezometers;
- Collecting 83 investigation soil samples;
- Installing and developing five new monitoring wells;
- Measuring water levels and collecting groundwater samples from the monitoring wells;

- Testing four monitoring wells for hydraulic conductivity using the rising head slug test method; and

- Surveying the locations of all push-sample soil borings, push-sample piezometers, and monitoring wells.

6.2 CONCLUSIONS

IRP Site No. 4 is a drainage ditch which is located along the north and west perimeters of the base, and which bisects the south half of the base. The drainage ditch is approximately 1,000 feet in length on the southern side, 2,000 feet long on the western side, 800 feet on the northern side, and approximately 10 feet wide in most places. Ditch depth is approximately three feet. The majority of the site is unpaved, with the exception of a cemented culvert area on the southern side.

Soil and groundwater samples were collected from IRP Site No. 4 and submitted for laboratory analyses to determine whether contamination exists at the site, and if it does exist, to determine the nature, extent, and source of the contamination. The SI provided data necessary to reach a decision point regarding environmental concerns at the site. Suspected contamination at the site included petroleum fuels and other petroleum substances; therefore, soil and groundwater samples were submitted for analysis of VOCs, TPH measured as GRO and DRO, PAH, and lead.

The local groundwater flow direction at the site was generally to the northwest at an average gradient of approximately 0.0037 feet per foot. Hydraulic conductivities estimated from slug test data in three monitoring wells ranged from 16.65 to 301.11 gal/day/ft^2 (7.85×10^{-6} to 1.42×10^{-4} cm/sec). The velocity ranges from 15.07 to 272.45 feet/year. Due to the heterogenous nature of the lithology (typical of glacial deposits), it is more likely that the gross groundwater velocity at the site is toward the lower velocity range.

6.2.1 Soil Contamination

The WDNR has established interim soil cleanup guidelines under NR 720 for individual BTEX constituents, GRO, DRO, and lead (see Table 6.1). The WDNR establishes cleanup levels for contaminants not covered under NR 720 (i.e., PAH and other VOCs) on a site-specific basis.

Table 6.1
Summary of Analytes Exceeding Action Levels
128th ARW, General Billy Mitchell Field ANGB, Milwaukee, Wisconsin

Sample Matrix	Sample Location	Analyte	Concentration	WDNR Cleanup Guidance
Soil	7 PS/PZ locations 4 PS/PZ locations	DRO GRO	100 - 1,700 mg/kg 220 - 4,600 mg/kg	100 mg/kg 100 mg/kg
	7 PS/PZ locations 5 PS/PZ locations 6 PS/PZ locations 6 PS/PZ locations	Benzene Toluene Ethylbenzene Xylenes	6.8 - 25,000 µg/kg 4,100 - 130,000 µg/kg 4,400 - 68,000 µg/kg 6,300 - 300,000 µg/kg	5.5 µg/kg 1,500 µg/kg 2,900 µg/kg 4,100 µg/kg
Groundwater	4 PS/PZ locations 04-003 MW	Benzene	5.1 - 3,900 µg/L 7,200 µg/L	5 µg/L
	04-003 PZ 04-003 MW	Toluene	12,000 µg/L 32,000 µg/L	343 µg/L
	04-003 PZ 04-003 MW	Ethylbenzene	3,400 µg/L 4,100 µg/L	700 µg/L
	04-003 PZ 04-003 MW	Xylenes	20,000 µg/L 21,000 µg/L	620 µg/L
	04-004 PZ	Benzo(a)pyrene	3.02 µg/L	.003 µg/L
	04-003 MW	Naphthalene	518.3 µg/L	40 µg/L
	5 PS/PZ locations 4 MW locations	Lead	27 - 290 µg/L 26 - 410 µg/L	15 µg/L

µg/L – Micrograms per liter.
µg/kg – Micrograms per kilogram.
MW – Monitoring well.
PS – Push-sample location.
PZ – Piezometer.
DRO – Diesel Range Organics.
GRO – Gasoline Range Organics.
WDNR – Wisconsin Department of Natural Resources.

Two general areas at the base exhibit soil concentrations of BTEX constituents, DRO and GRO above WDNR cleanup guidelines: (1) the northernmost section of the drainage ditch, near the outlet to Bailey's Pond, extending west to push-sample location 04-0011PS; and (2) the area adjacent to the southern and southwestern sections of the drainage ditch, extending from the drainage ditch/Chicago & Northwestern Railroad intersection to the area of the new taxiway. In general, higher contaminant concentrations tend to be found at depths greater than 5 feet BLS to the maximum depth of investigation, approximately 12 feet BLS.

In the area near Bailey's Pond and the access taxiway, maximum contaminant concentrations detected in soil are as follows: benzene at 15 μg/kg; GRO at 62 mg/kg; DRO at 140 mg/kg; and lead at 93 mg/kg. Individual PAH were detected at concentrations up to 8,780 μg/kg in soil samples collected from push-sample location 04-005PS. WDNR soil cleanup guidelines for benzene and DRO were exceeded. The highest concentrations were located in the area of the outlet into Bailey's Pond.

The highest concentrations of analytes detected in soil samples were identified in areas adjacent to the south and southwestern sections of the drainage ditch. In this area, benzene was detected in soil at concentrations up to 25,000 μg/kg; other individual BTEX compound concentrations were detected up to 300,000 μg/kg; GRO was detected up to 4,600 mg/kg; DRO was detected up to 1,700 mg/kg; and lead ranged from 1.6 mg/kg to 50 mg/kg. Individual PAH compounds were detected in soil samples collected from push-sample locations 04-013PS and 04-025PS at concentrations up to 15,300 μg/kg. WDNR soil cleanup guidelines for benzene, toluene, ethylbenzene, total xylene, GRO, and DRO were exceeded in this area. Specifically, the highest contaminant concentrations were detected in soil samples collected along the south and southwest portions of the ditch (west of Buildings 113 and 114, and immediately south of Building 128).

DRO contamination was also detected at 100 mg/kg, the WDNR cleanup guideline, in one sample only in the vicinity of Buildings 107 and 108, located near the southeast corner of the aircraft apron. This sample, 04-037PS, was collected from approximately 80 feet west of Building 107.

6.2.2 Groundwater Contamination

The WDNR has established groundwater protection standards under NR 140 for individual BTEX constituents, the PAH benzo(a)pyrene and naphthalene, and lead (see Table 6.1). There are no WDNR groundwater protection standards for DRO and GRO. The WDNR establishes cleanup level for contaminants not covered under NR 140 on a site-specific basis.

Areas of the base where contaminant impact to groundwater exceeds WDNR protection standards generally coincided with the two previously described areas where soil contaminants were found to exceed soil cleanup guidelines (in the south and southwestern portions of the drainage ditch and the area near Bailey's Pond).

In the area near Bailey's pond and the access taxiway, lead concentrations up to 290 μg/L were detected in screening groundwater samples from piezometer 04-002PZ. However, confirmation groundwater samples, collected from the nearest monitoring well to the area (4-002MW), approximately 90 feet south of piezometer 04-002PZ, did not exhibit detectable levels of lead. Benzene and other BTEX constituents were not detected at concentrations exceeding protection standards in screening or confirmatory sampling rounds; GRO was detected up to 280 μg/L in groundwater screening samples, but was not detected in confirmatory samples collected from monitoring well 04-002MW; DRO was detected up to 0.21 mg/L in groundwater screening samples, but was not detected in confirmatory samples collected from monitoring well 04-002MW.

The most significant contaminant impacts to groundwater were identified in areas adjacent to the southern and southwestern sections of the drainage ditch. Groundwater screening samples were collected from two piezometers (04-003PZ and 04-004PZ), and two rounds of confirmatory groundwater samples were collected from four monitoring wells (04-001MW, 04-003MW, 04-004MW, and 04-005MW) in this area. The highest concentrations of benzene, 3,900 μg/L and 7,200 μg/L, were detected in groundwater samples from piezometer 04-003PZ and monitoring well 04-003MW, respectively. Benzene, toluene, ethylbenzene, and xylene concentrations detected in groundwater samples from both these sampling points exceeded WDNR protection standards (see Table 6.1). Both of these sampling points are located adjacent to the drainage ditch in the vicinity of Buildings 113 and 114. Benzene concentrations and other BTEX constituents detected in confirmation groundwater samples from the other monitoring wells in the area were detected at concentrations less that protection standards. GRO was detected at a maximum concentration of 100,000 μg/L in groundwater sampled from monitoring well 04-003MW, but was not detected in the other monitoring wells in the area; DRO was detected at a maximum concentration of 60 mg/L in groundwater sampled from monitoring well 04-003MW and at respective concentrations of 1.4 and 0.1 mg/L in groundwater sampled from monitoring wells 04-005MW and 04-004MW. Also, benzo(a)pyrene was detected at a concentration of 3.02 μg/L in groundwater screening samples collected from piezometer 04-004PZ. Naphthalene was detected at a concentration of 518.3 μg/L in a confirmation groundwater sample from monitoring well 04-003MW.

Lead was detected above groundwater protection standards in screening samples at concentrations ranging from 34 to 170 μg/L, and in confirmation samples at concentrations ranging from 26 μg/L to 410 μg/L. The highest lead concentrations were detected in groundwater sampled from monitoring well 04-003MW.

6.3 DISCUSSION OF POTENTIAL CONTAMINANT SOURCES

The PAH benzo(a)pyrene and lead were detected in groundwater screening samples collected from piezometer 04-004PZ, located near the site of the 1968 West Shore Pipeline spill. No other groundwater contaminants exceeding WDNR protection standards were detected in this area. Concentrations of various PAH in soil, ranging up to 15,300 μg/kg, were detected in push-sample location 04-025PS, located in the same area.

The highest concentrations of analytes detected in soil samples were identified in areas adjacent to the south and southwestern sections of the drainage ditch, and the most significant contaminant impacts to groundwater were identified in the same areas. According to base personnel who were present at the base during the late 1960s, prior to construction of the present buildings, the southwest corner of the base was at a lower elevation than the aircraft apron and was a marshy area with trees, grass, cattails and brush. The base did not mow the area, and it was left in a natural state; Buildings 113, 114, 128 and 109 had not yet been built. During the 1968 West Shore pipeline rupture, fuel drained into the southwest corner of the base, and no attempt was made at recovery. As a result of the pipeline rupture, the marshy area in the southwest corner of the base filled with fuel, and the overflow followed the aircraft apron ditch where it ultimately flowed into Bailey's Pond. The fuel floated on the water in Bailey's Pond and was recovered.

GRO and DRO were detected at the highest concentrations in the southwestern portion of the base, especially at piezometer 04-003PZ (3 - 5 feet and 5 - 7 feet intervals), with concentrations as high as 1,700 mg/kg for DRO and 4,600 mg/kg for GRO. Other GRO and DRO concentrations that did exceed or nearly exceeded the State action levels were detected throughout the drainage ditch from the railroad tracks and then along the southern outer portion of the base into Bailey's Pond. Concentrations were suspected to be greater in the southwest portion of the base, which was downgradient from the suspected source of contamination.

A suspected potential contaminant source located near the southwest portion of the drainage ditch were two former USTs. The USTs, located at Building 114, had failed tightness tests. Upon

subsequent removal of the USTs, however, preliminary analytical results revealed they were not the source of gasoline in the site soil.

The area of DRO soil contamination near Buildings 107 and 108 appears unrelated to the suspected source of contamination at IRP Site No. 4. Potential sources of contamination are the POL facility and spills and/or runoff from the aircraft apron.

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7.0 RECOMMENDATIONS

Based on the results of the SI conducted at IRP Site No. 4, the following recommendations are presented:

- Remedial investigation (RI) work, including the installation of additional monitoring wells and drilling of soil borings, is needed to further delineate contaminant-impacted soil and groundwater along the drainage ditch in the southern and southwestern area of the base and in the area of Bailey's Pond. Additionally, monitoring wells should be installed along the west and northwest edge of the base to determine both the horizontal and vertical extent of contamination.

- A background sampling program should be undertaken in areas away from known or suspected sources of contamination in order to establish soil and groundwater conditions in the area.

- Additional investigation is recommended to evaluate potential sources of the DRO contamination detected in soils near Buildings 107 and 108, which appear unrelated to IRP Site No. 4. Potential contaminant sources are the POL facility and the aircraft apron.

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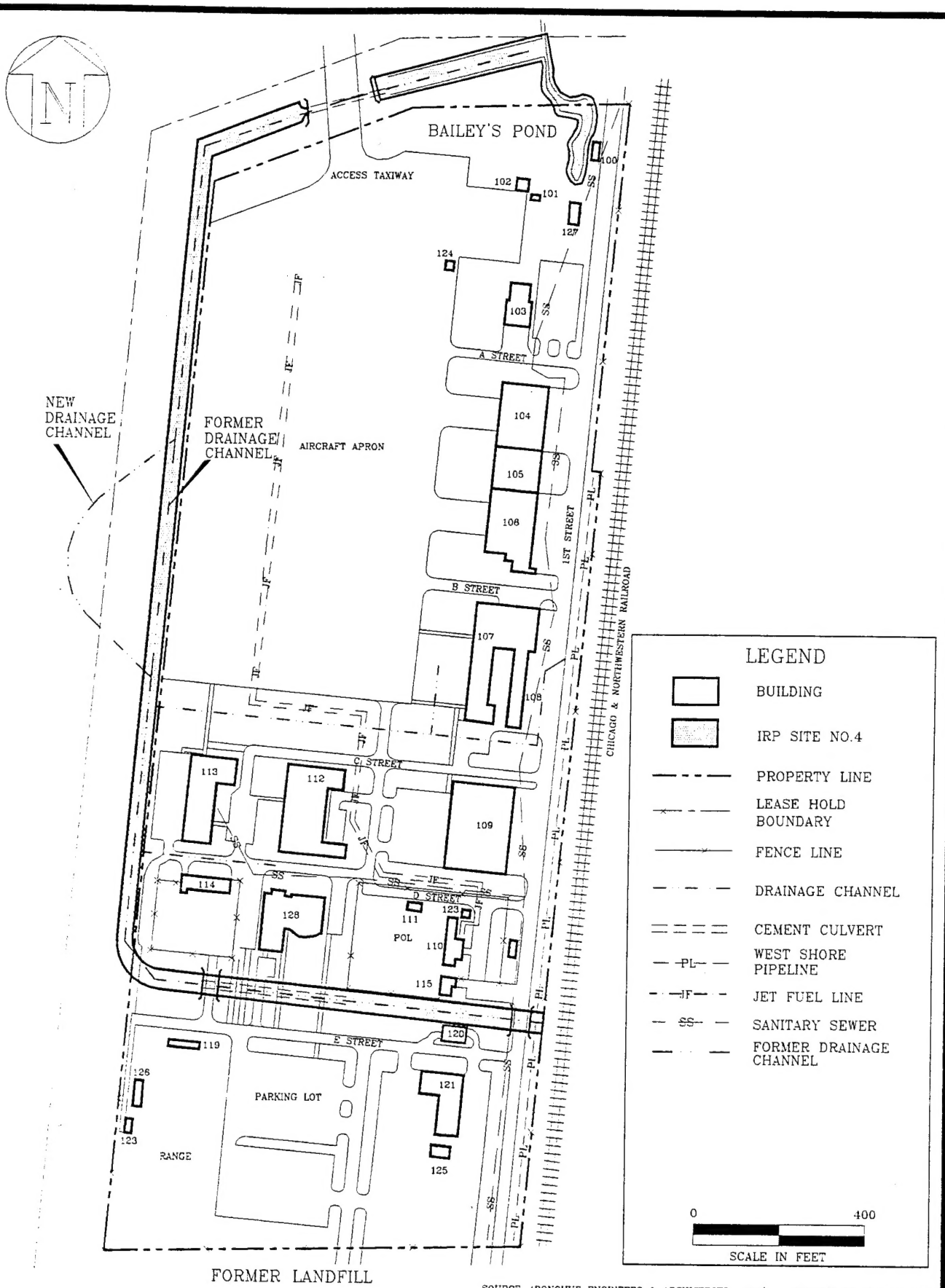

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INSIDE BACK COVER
BILLYMIT BASEMAP

IRP SITE LOCATION MAP

128th ARW, Gen. Billy Mitchell Field ANGB
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